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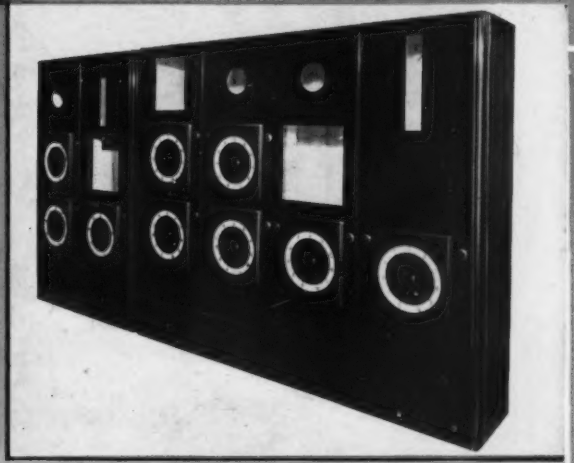
INSTRUMENT Practice AUTOMATION & ELECTRONICS

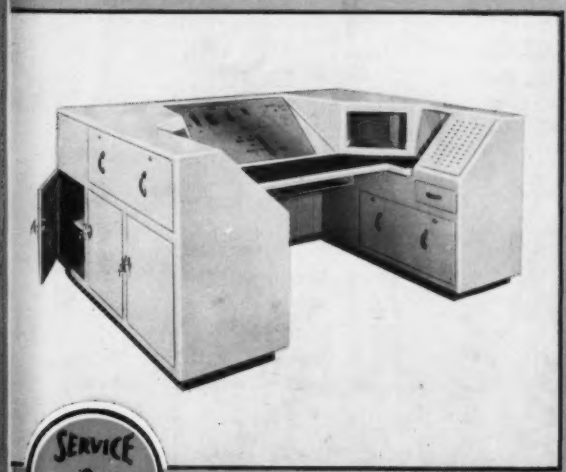
Vol. 13 No. 12 Published Monthly December 1959

Control Rooms and Desks

INSTRUMENT



Panels, Cubicles and Consoles



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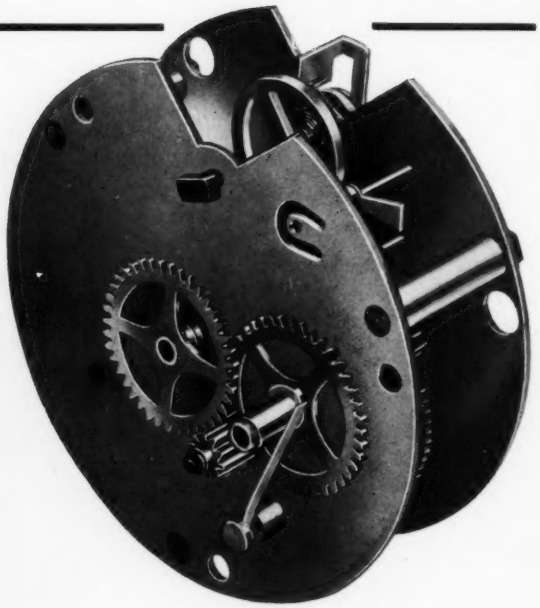

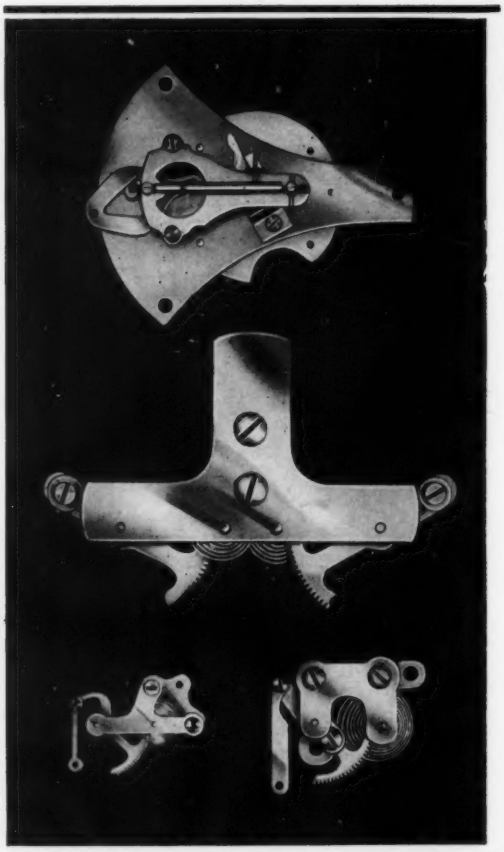

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for switchboard mounting

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* **Models are available for direct wire remote indication.**

Instruments in this range are of an advanced design incorporating many features including platform type scales. The movements are robust in construction and have a high torque/weight ratio. Low burden types are available for miniaturised control panel installations, with associated interposing voltage- and current-transformers.

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These Instruments comply with B.S.89-1954 Industrial Grade and other International Specifications.

Literature available on request to:
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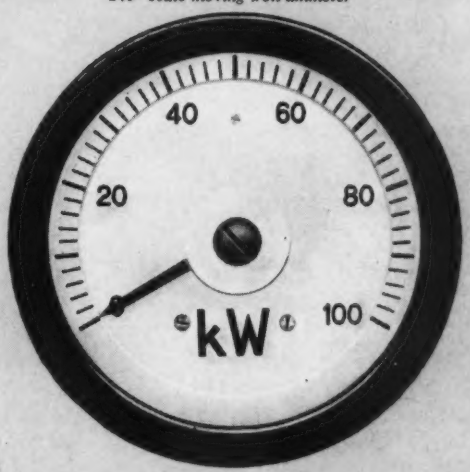
240° scale moving iron ammeter



240° scale dynamometer wattmeter

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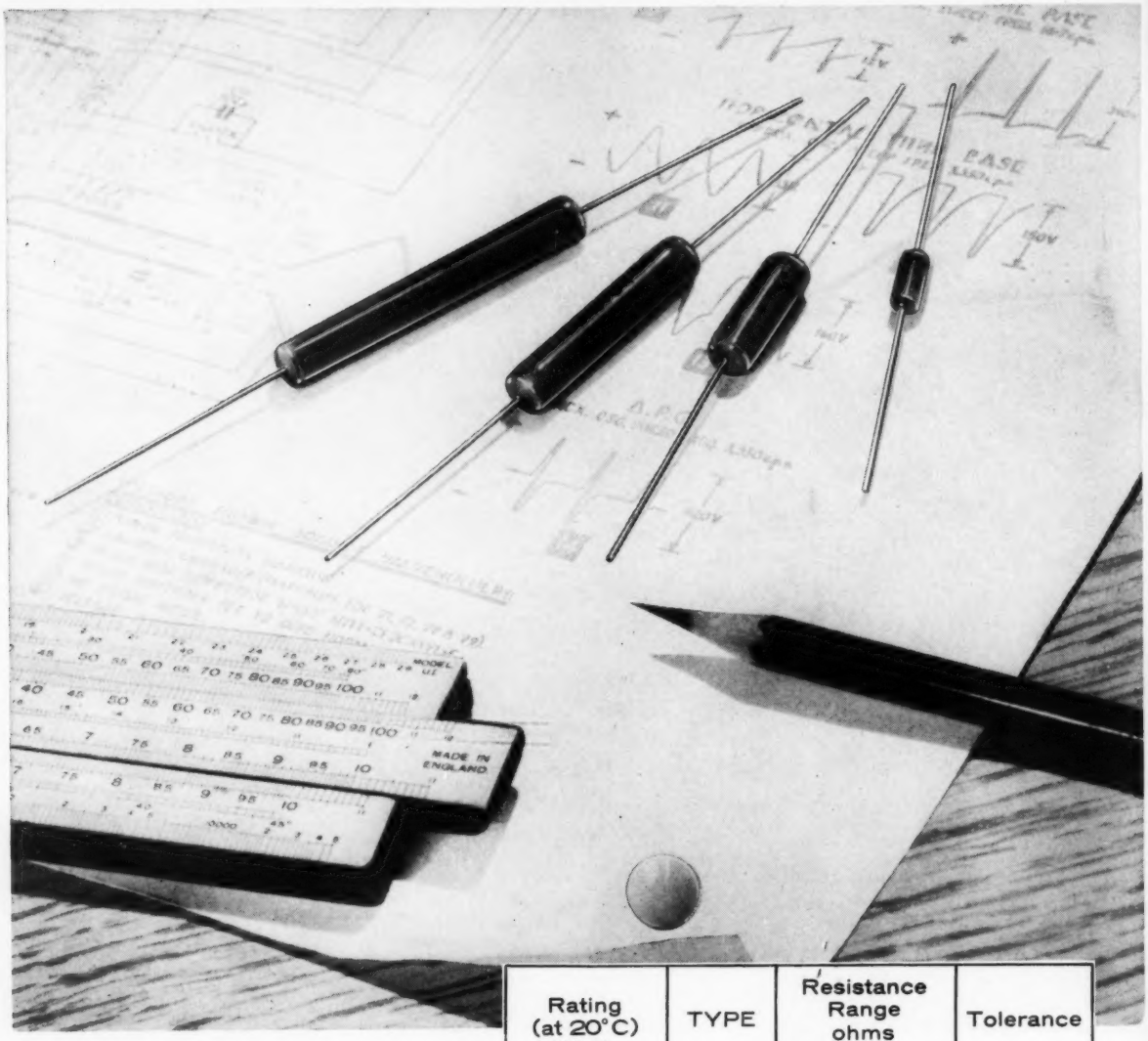

Rating (at 20°C) Watts	TYPE	Resistance Range ohms		Tolerance
		Min	Max	
4	MV1A	1 10	9·9 6,800	10% 5%
7	301A	2	68,000	5%
10	302A	4	140,000	5%
5	306A	1	33,000	5%

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Advance* Wires of this 60/40 copper-nickel alloy have a low temperature coefficient and a fairly high specific resistance—important properties in precision resistors which must have constant resistance over a wide temperature range.

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NICHROME REGD TRADE MARK

Cheadle Heath, Stockport, Cheshire.

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by Advance – to be sure!

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- Sine or Square Wave Output
- Output Voltage (High Impedance)
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- Distortion less than 1% at 1,000 c/s

Nett Price in U.K. **£30**

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- Output (Sine Wave only)
  Into 600 ohms 0·1 mW. to 1 W. continuously variable
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  600 ohms, unbalanced
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116 SMOOTHING CHOKES *

with inductances
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to
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LARGE CAPACITY PROJECTOR FOR RAPID, ACCURATE CHECKING AND INSPECTION OF HIGH PRECISION COMPONENTS.

Typical of many applications of the projector from inspection of sections of 34 inch diameter castings down to small watch parts, the illustration shows a 34 hole template being checked for co-ordinate positioning accuracy of the holes to within 0·0003 in. at 50× magnification.

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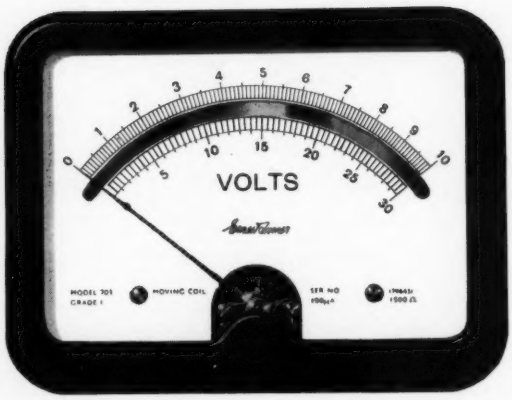
Ernest Turner precision-built electrical measuring instruments give accuracy, dependability and ease of reading and keeping pace with the ever widening field of electronics, Ernest Turner Electrical Instruments offer a wide range of instruments to meet specific requirements and individual applications. For more than 35 years, in this country and in many parts of the world, wherever there has been a job of precise electrical measurement to be done, the choice has been Ernest Turner instruments



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DIAPHRAGM CONTROL VALVES

Accurate, reliable, and economical, these Blakeborough types do full justice to the performance of the controlling instrument—hence their widespread use on modern automatic process control systems. An advanced and comprehensive range, well worth investigating.

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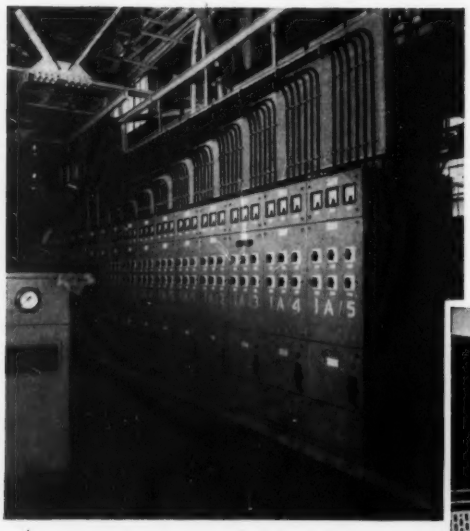
Pyrotenax *Experience*

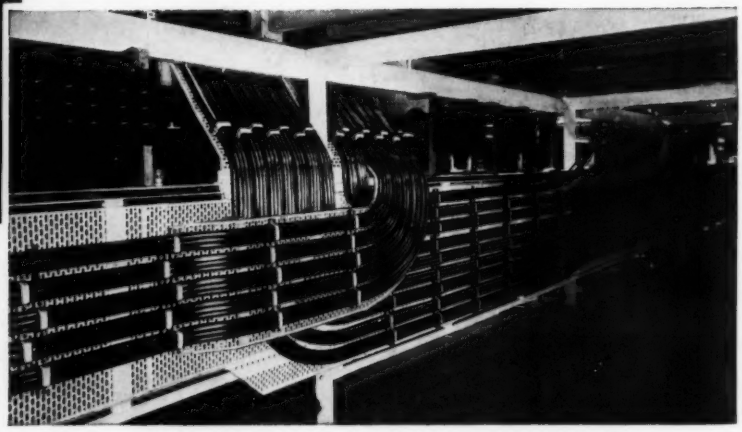
serves the Atomic Age....



Main control switchboard at one of the United Kingdom Atomic Energy Authority Research Establishments showing Pyrotenax cables feeding lighting, power and instrument circuits.

Men are working on the lonely coasts of Britain, and vast and unfamiliar structures are rising to provide the Nation's new electrical power sources.

This is visible progress. Yet, in the changing scene there are constants. Pyrotenax M.I.C.C. Cables, for instance, have been the consistent choice of electricity supply authorities for years. Twenty years ago the most "modern" power stations installed "Pyrotenax"—and the same original cabling still serves today. Little wonder that in this present age too, "Pyrotenax" is being specified for the lighting and power services in the various atomic plants of the United Kingdom Atomic Energy Authority. Current *generating* may change, but current *carrying* is always best left to "Pyrotenax"!



Power and instrument cabling at the rear of the main switchboard. (Contractor N. G. Bailey Limited Leeds.)

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Pyrotenax

m.i. COPPER COVERED CABLE

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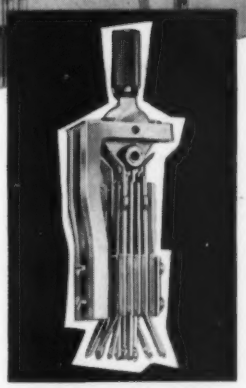
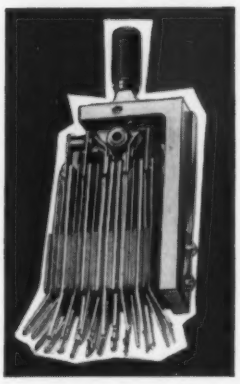
GD 127

Circle 64 for further information

57 KEYS





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A T.M.C. range of 57 vertical Lever Keys has Type Approval from the Radio Components Standardisation Committee . . . with this distinction: they are the first Lever Keys manufactured in the U.K. to receive *unqualified approval* (Class H2, temperature category—40°C to +70°C) as catalogued in R.C.L 153, Issue 1, pages 5 and 7.

These Keys are used in Telecommunications apparatus, Electrical Testing equipment, Radio Transmitting and Receiving instruments and other appliances requiring low voltage multiple switching. They have won an unparalleled reputation for maintaining the highest standard of performance over exceptionally long periods. Each is produced under the control of a stringent specification and is subject to critical adjustment and inspection before it is allowed to leave the factory. Other ranges in both Standard and Tropical finishes are also available.

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Baldwin Atomat Nucleonic Thickness Gauges

ACCURATE, CONTINUOUS, NON-CONTACT INSPECTION

SAVES MATERIAL, LABOUR AND TIME!

The Atomat Principle

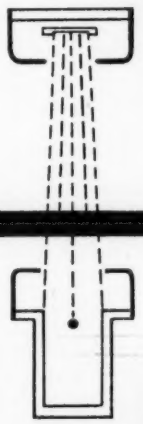
RAY SOURCE

MATERIAL

RAY DETECTOR

Amount of rays passing through material indicates thickness or weight per unit area.

That's the very basic explanation of the Atomat principle. There are three main gauges; the Atomat Transmission Gauge, the Atomat Differential Gauge and the Atomat Backscatter Gauge. In addition there are special purpose variations, made to meet the requirements of many different industries.



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- **Time and material saving both in production and setting up**
- **High accuracy**
- **Calibration in your usual units of measurement**
- **Continuous readings for materials in constant production**
- **Auto standardisation and control if you require**
- **Minimum maintenance**

Baldwin Atomats are already boosting production and cutting costs in the paper, metal rolling, rubber and plastics industries. Highly successful applications also include the measuring of selenium on aluminium, coatings of paint and lacquers, density of wood chips, coatings of grit on abrasive papers and padding and resin impregnation in the textile industry. But the potential of Baldwin Atomat Nucleonic Gauges has hardly been tapped.

Is there a place for them in your plant?

Send for the Baldwin Brochure LP. 124
It gives full information on
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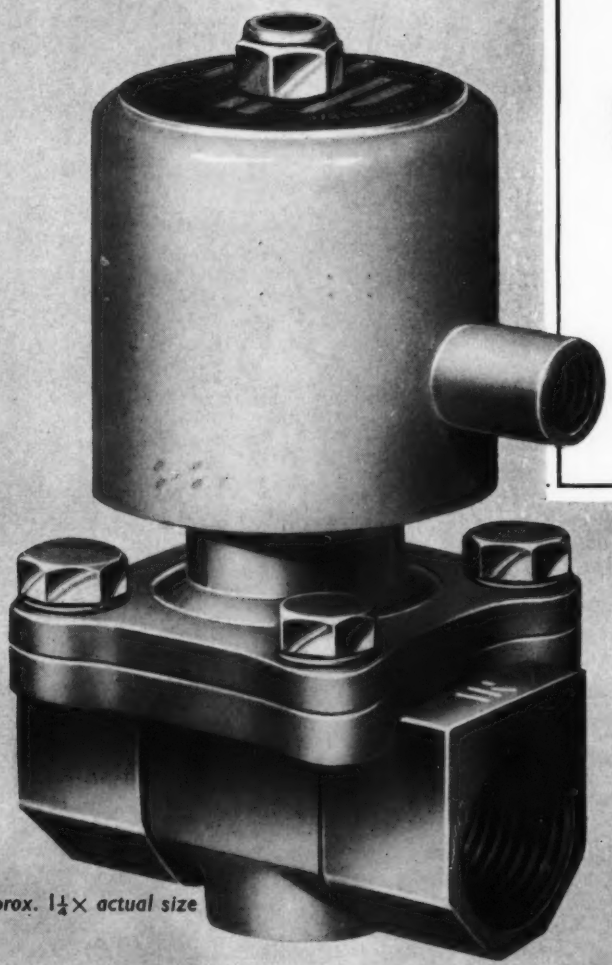

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—illustrated is the Type DF high-performance valve suitable for use over a wide range of pressures

One of the outstanding new range of solenoid valves recently introduced by ETHER LTD., the DF is a pilot-operated diaphragm valve. It is designed for use, over a wide range of pressures, with town gas, propane, butane, water, compressed air, or light fuel-oil. The standard model has ¼" B.S.P. female connections. Non-standard versions can be supplied to order.

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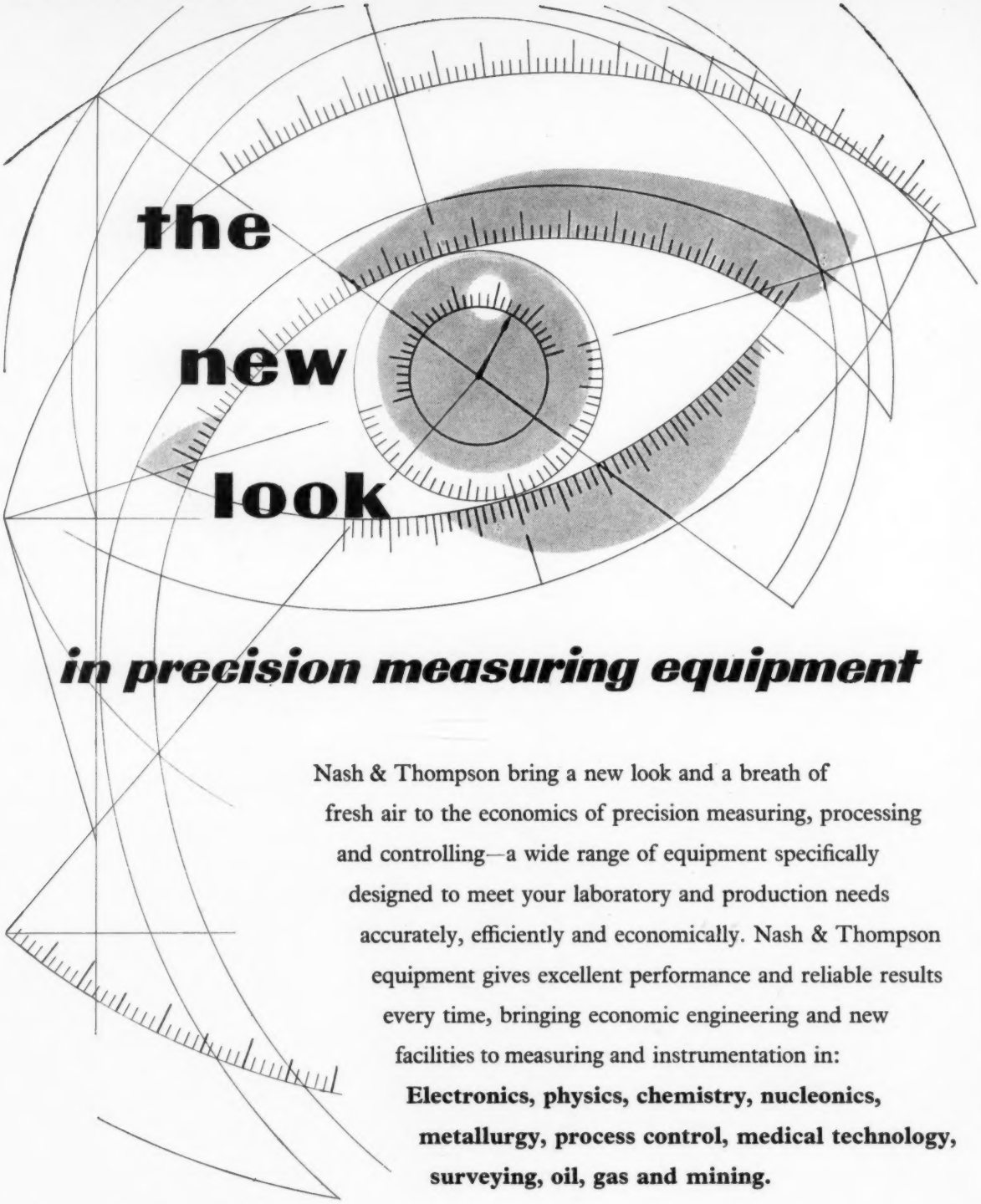

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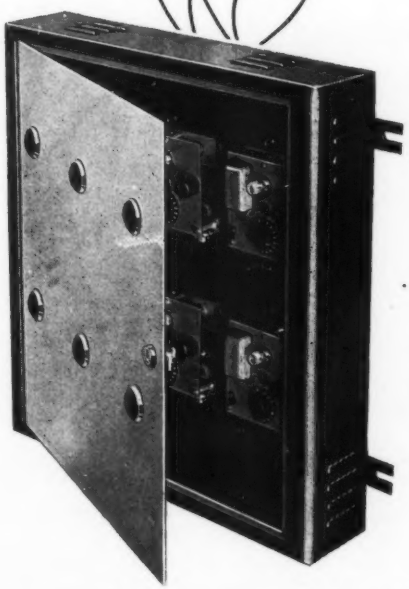
MULTIPLE CONSTRUCTION or single units



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TEKTOR MINOR

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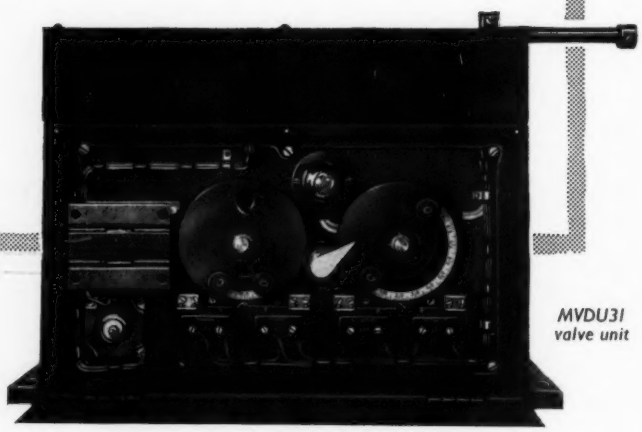
DEPENDABLE · DURABLE · SERVICABLE

Valve unit type MVDU11 Operating two V-ported valves



MVDU31 valve unit

30 YEARS EXPERIENCE of the requirements of Automatic Temperature Control in the industrial field is embodied in these units. Extensively used for regulating fuel valves and voltage regulators. Units have uniform stroke movement for uniform impulses over whole range.

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I.I.C.

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- ★ Complete over-range protection to body rating
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- ★ Same bellows unit for all pressure ratings
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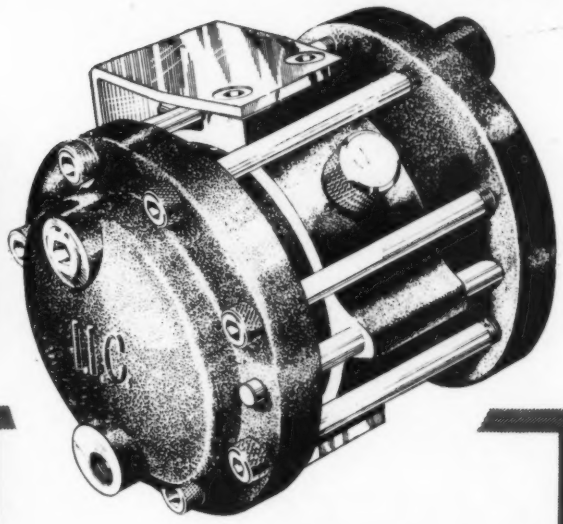
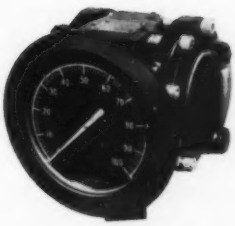
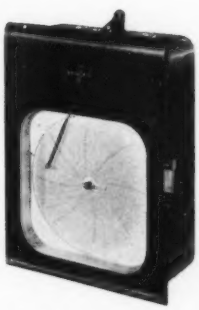


Above: The I.I.C. differential pressure flowmeter



Above: Model 800-6 Differential pressure indicator



Above: Bristol's 'Series 500' recorder (supplied with or without spring driven or electric integrator)

Right: Model 700 MT pneumatic differential pressure transmitter

Further information on the I.I.C. flowmeter is freely available from

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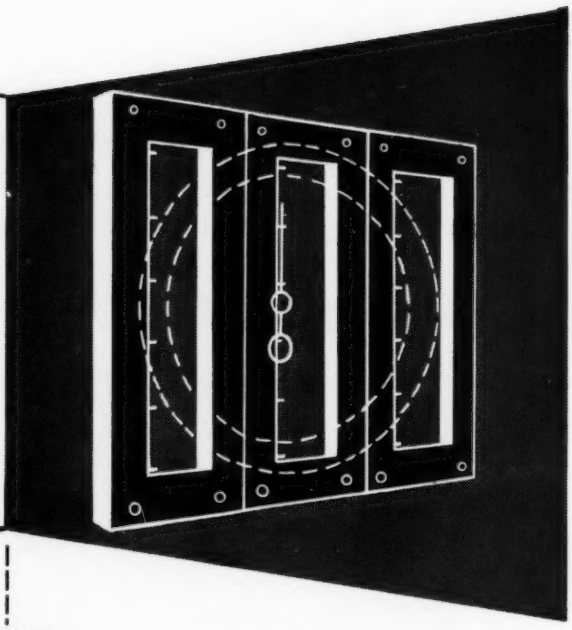
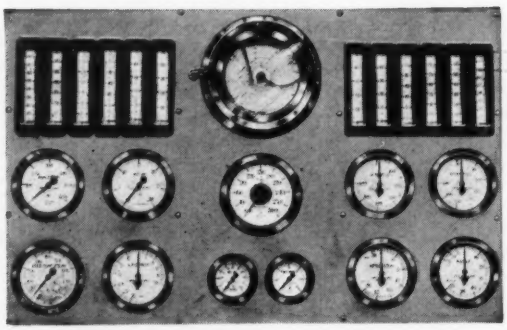
FIT SYDNEY SMITH FLAT-FACE EDGEWISE PRESSURE GAUGES

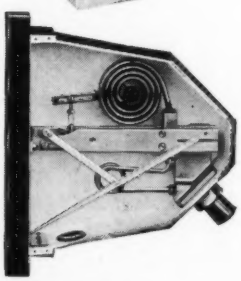


" GRASSHOPPER " PATENT
Size 8" in accordance with B.S.S. 1780-1951.



The TWELVE Edgewise Gauges in the panel above occupy approximately **HALF THE SPACE** *of the ELEVEN conventional dial type.*

Being Flat-Faced there is no Glint



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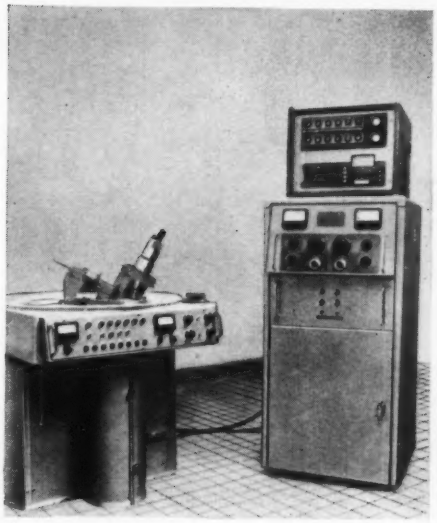

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permits the quantitative chemical analysis of volumes of material down to 1 micron cube. It is designed to cover the range of elements from uranium to titanium. With additional equipment—a proportional counter, amplifier and pulse height analyser—the range can be extended from titanium to aluminium.

In this micrograph each black dot represents an area of approximately 1 micron diameter studied by the x-ray micro-analyser at the surface of a bismuth copper aluminium alloy. Five separate phases occurring in the fusion of the alloy were identified.

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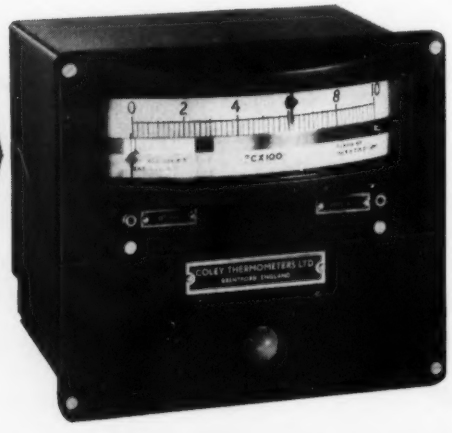
Leaflet Z5 will tell you all about it.



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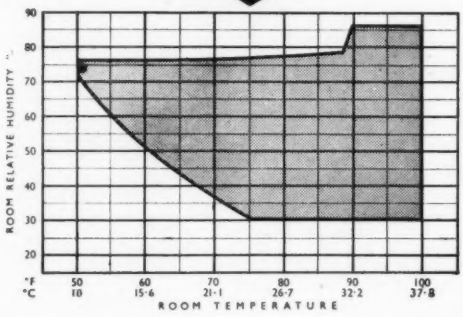
. . . the economic approach to precision humidity and temperature control to any conditions within this area



With Air Conditioning Cabinets of the type illustrated, rooms up to 3,000 cubic feet capacity can be conditioned and with agreed installation layouts can be maintained to within ±0·5°F and ±0·75% R.H. settings overall.

The unit is provided with an air outlet raised above bench level and a range of larger units is also available to special design for unusual applications.

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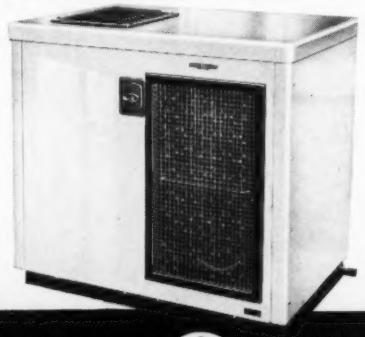
Our specialist Engineers will be pleased to examine and recommend conditioning equipment for YOUR schemes to ensure maintaining stringent conditions at economic cost.



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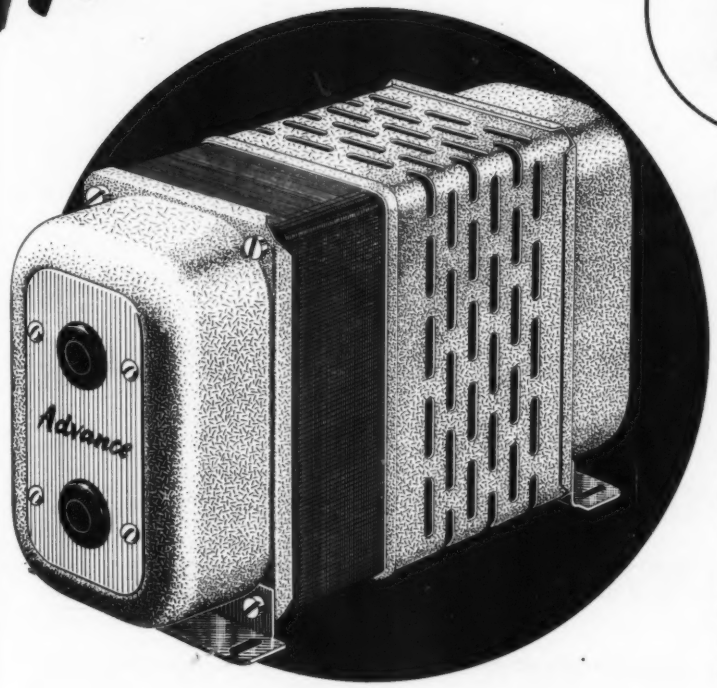

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Output Voltage	6V	6V
Output Capacity	25W	25W
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Weight	5lb	7lb
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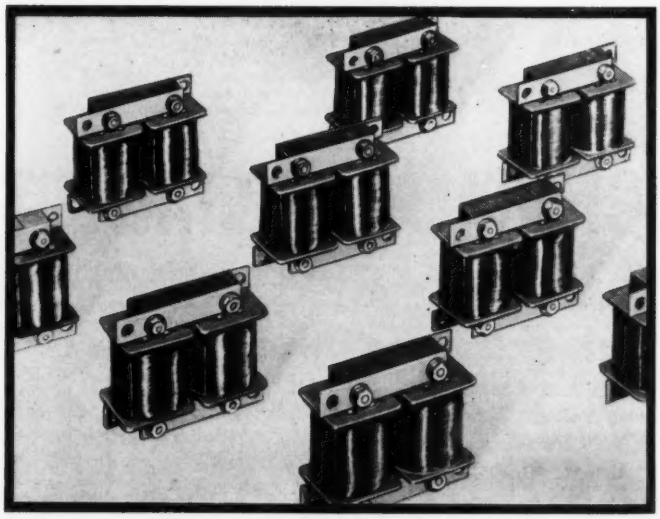
leads to your needs in TRANSFORMERS



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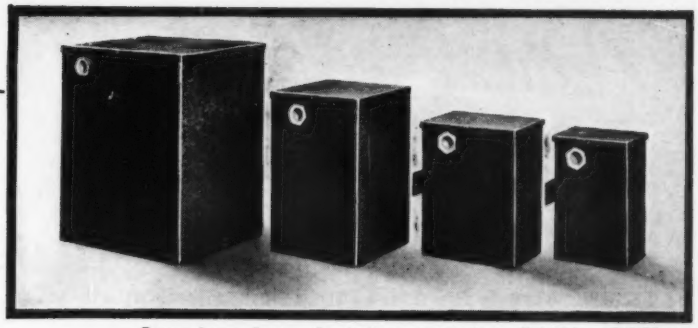
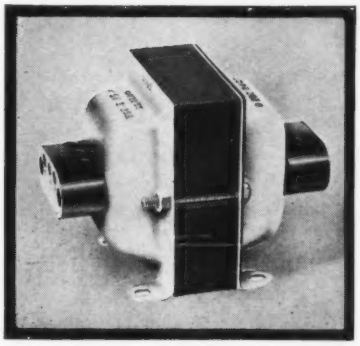
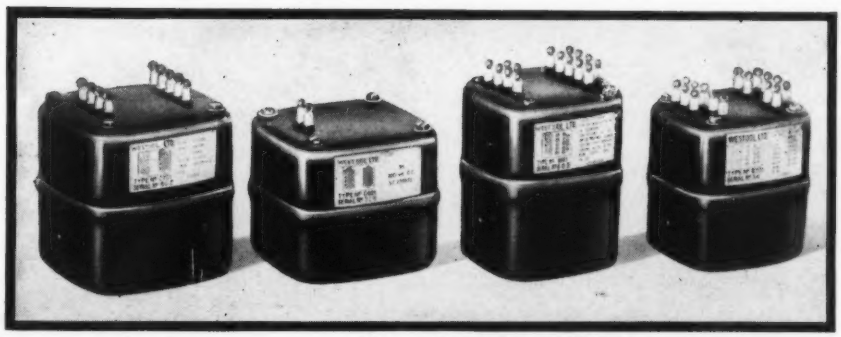


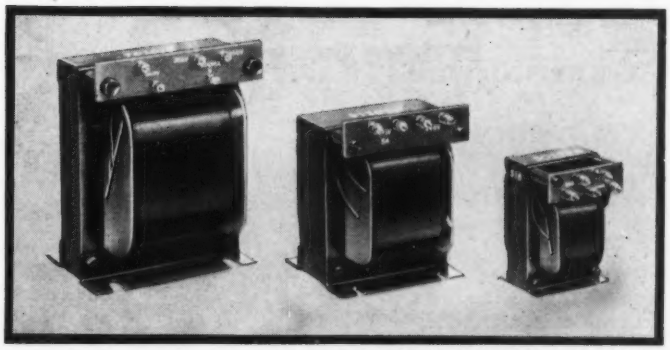
Encased transformer for indoor use made to B.S.171 or B.S.794 in ratings up to 5 KVA single phase and 20 KVA three phase at 50 cps.



Fully shrouded single phase transformer for ratings up to 500 VA at 50 cps.



Hermetically sealed, oil filled, 'C' cored transformers and chokes to RCL 215 for ratings up to 1½ KVA at 50 cps.



Open type single phase transformers to B.S.171 or B.S.2214 for ratings up to 5 KVA at 50 cps.

You can place complete reliance on Westool transformers which are made and tested in a modern factory on the most up-to-date equipment.

Westool 'know-how' on transformer design and manufacture is based on experience extending over very many years. They specialise in the production of small transformers up to 2,000 VA for sealed can transformers and 5 KVA single phase—18 KVA three phase.

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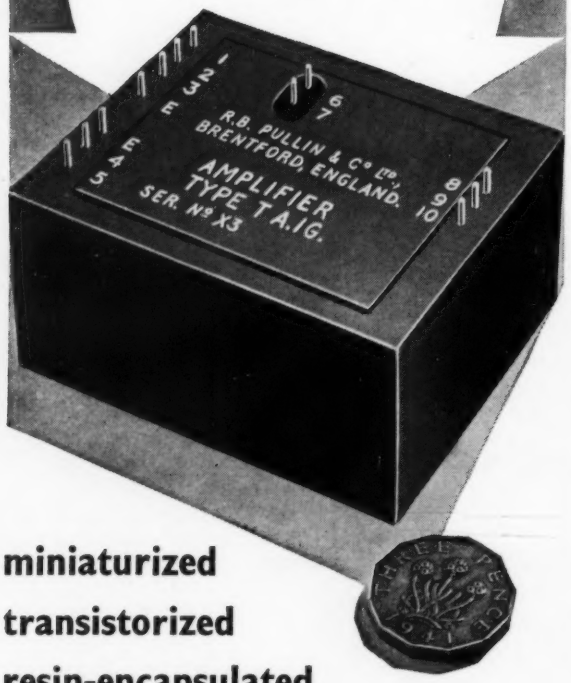

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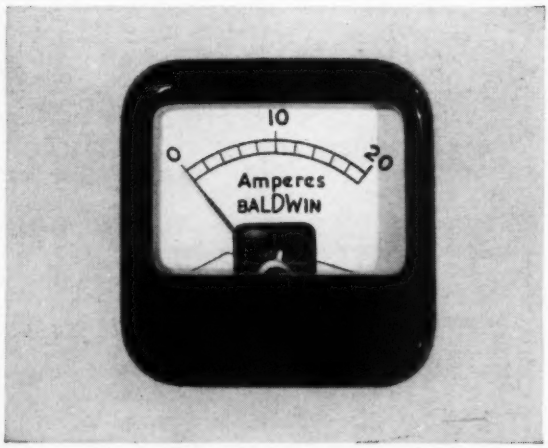

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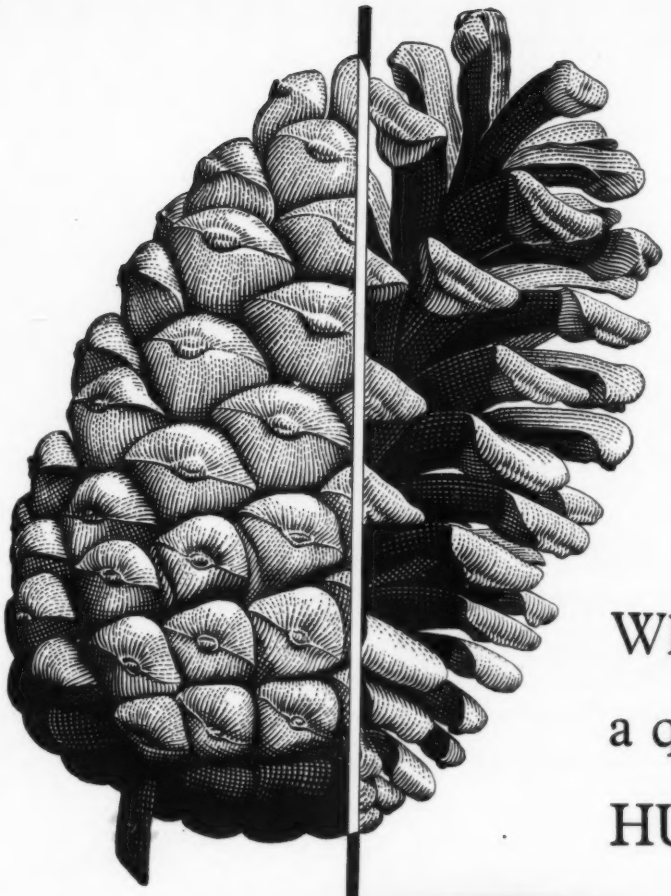

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For use on air up to 150 p.s.i. and port sizes to $\frac{1}{8}$ in. diameter screwed $\frac{1}{4}$ in. B.S.P. used for controlling air-operated cylinders and diaphragms with spring return.

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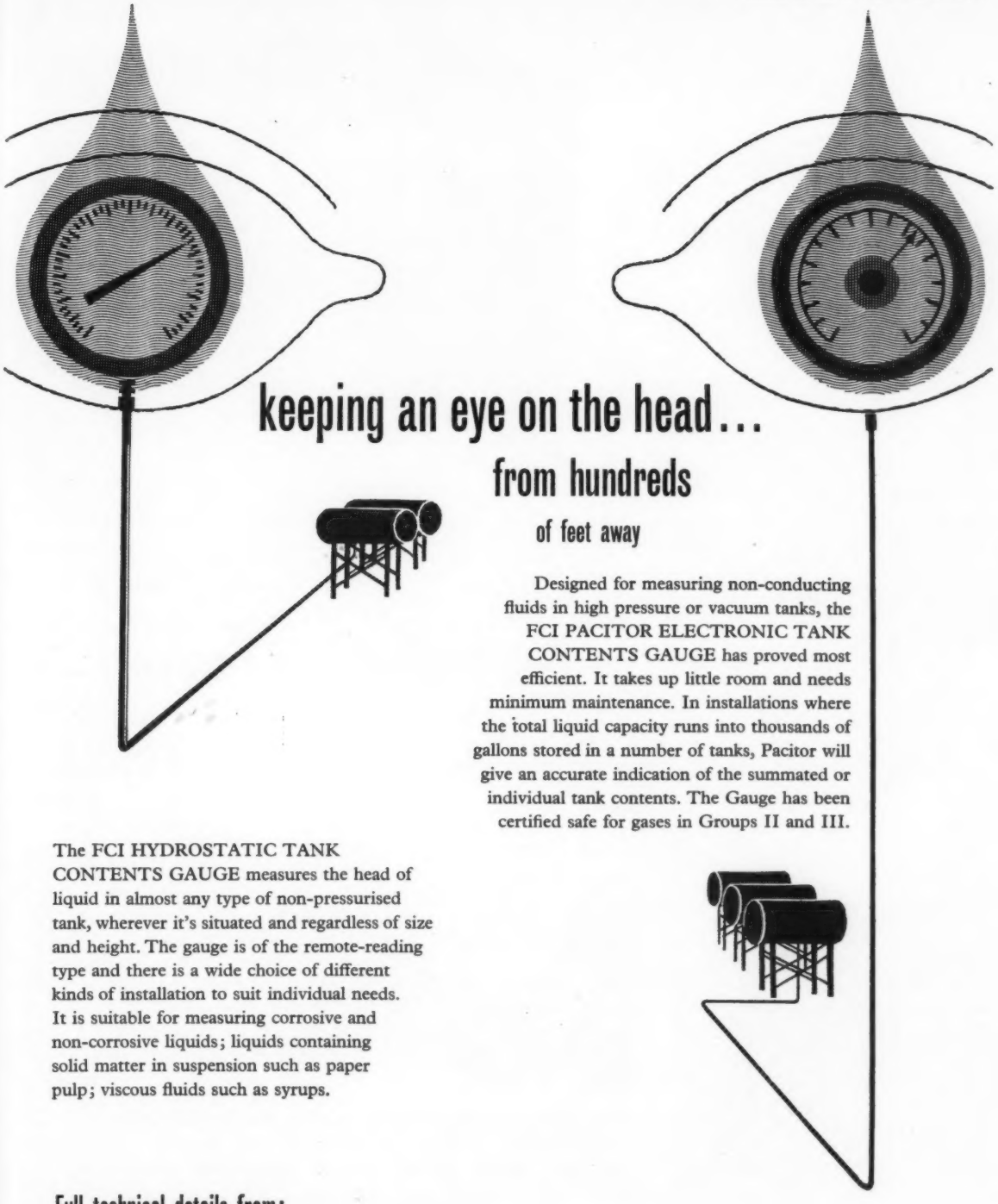

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from hundreds

of feet away

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The FCI HYDROSTATIC TANK CONTENTS GAUGE measures the head of liquid in almost any type of non-pressurised tank, wherever it's situated and regardless of size and height. The gauge is of the remote-reading type and there is a wide choice of different kinds of installation to suit individual needs. It is suitable for measuring corrosive and non-corrosive liquids; liquids containing solid matter in suspension such as paper pulp; viscous fluids such as syrups.

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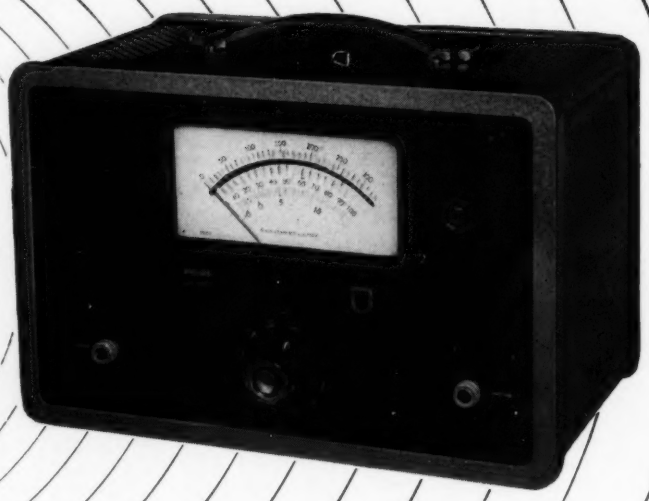

Eminently suitable for measurements in the acoustical and ultrasonic fields, electrical measurements of mechanical vibrations, measurements on I.F. and A.F. amplifiers and measurements on carrier telephone installations.

Technical data

Measuring ranges: 1 mV — 300V f.s.d. dB scale from — 80 dB . . . 52 dB O dB = 1 mW in 600 Ω (0.775 V).

Frequency range: 2 c/s...1 Mc/s

Overall accuracy: 20 c/s...100 kc/s ± 2.5%. 2 c/s...1 Mc/s better than ± 5%.

Input impedance: 1 mV...3 V range 4 M Ω parallel with 20 pF. 10 V...300 V range 10 M Ω parallel with 10 pF.

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This series of instruments covers the pressure range from 0 - 2 in. w.g. up to 10 tons p.s.i. and the number of different types covering various combinations of pressure and electrical circuits is in excess of 200.

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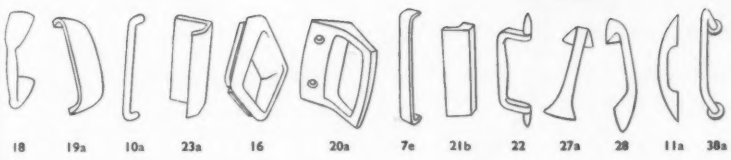

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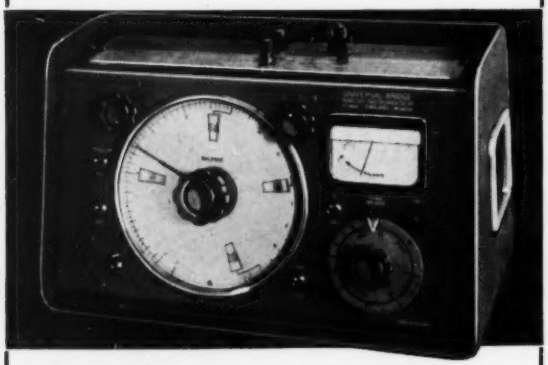
MARCONI UNIVERSAL BRIDGE TF 868B

New Simplicity in Impedance Measurements



INDUCTANCE from 1 μH to 100 henrys

CAPACITANCE from 1 μμF to 100 μF

RESISTANCE from 0·1 ohm to 100 MΩ

. . . these are the basic measuring capabilities of the TF 868B, and all three are measured without risk of confusion on a single direct-reading dial. In addition, there are precision phase-balancing facilities for measuring Q and tan δ.

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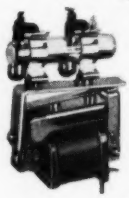

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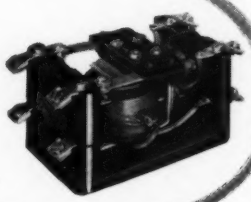

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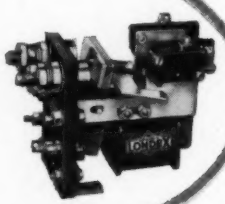

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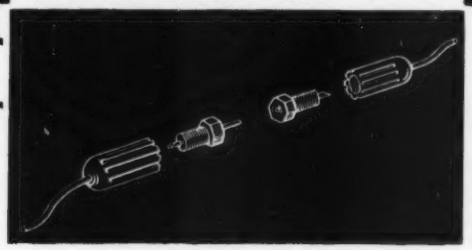

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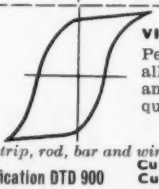

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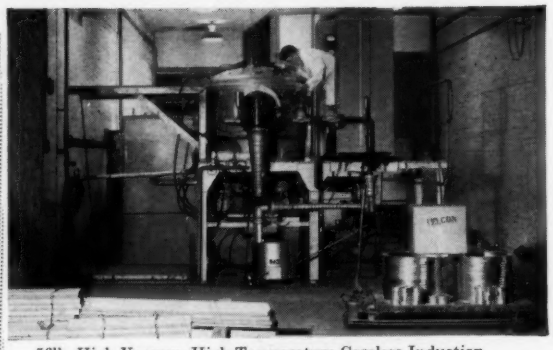

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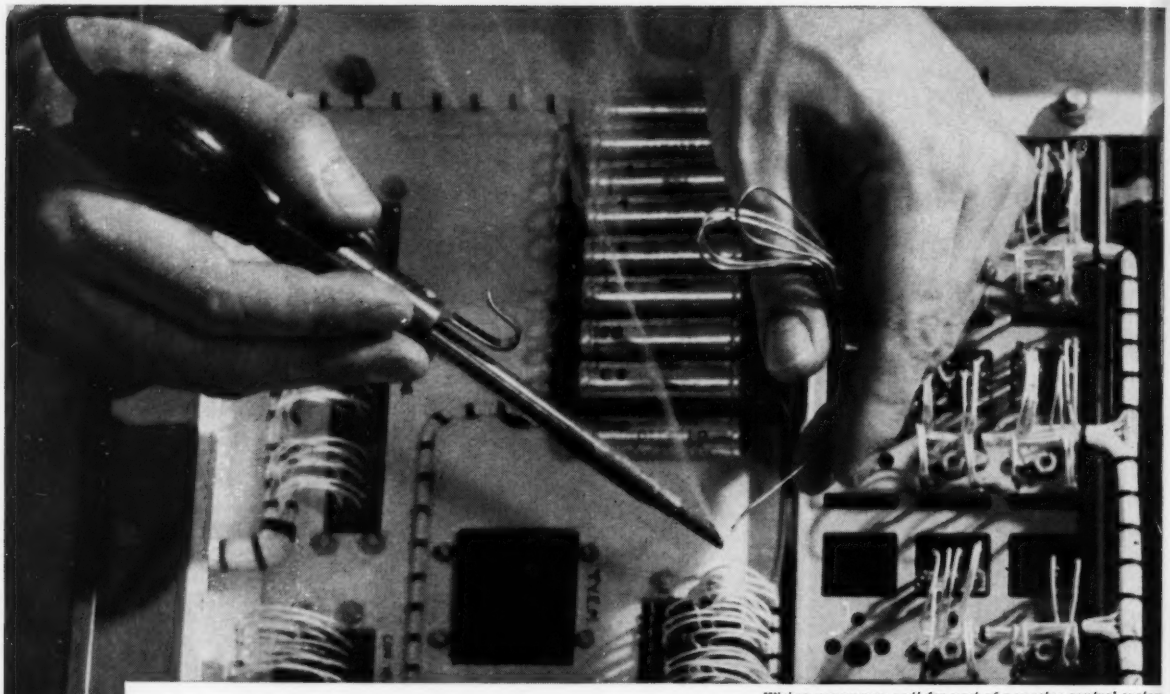

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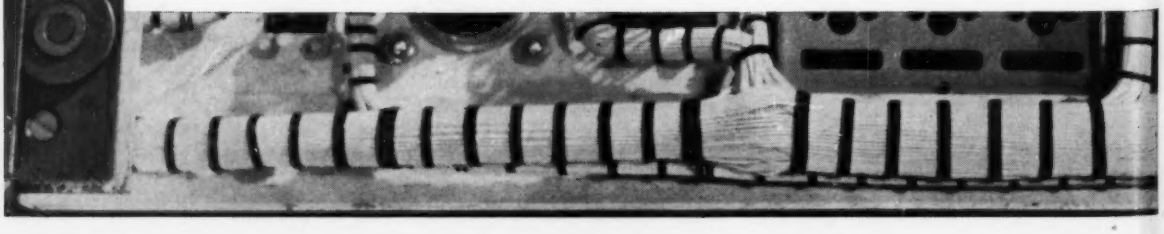

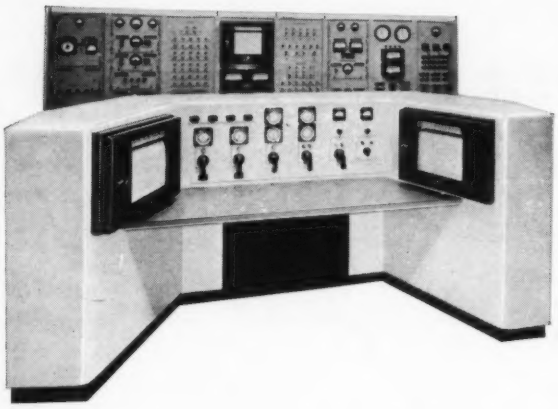

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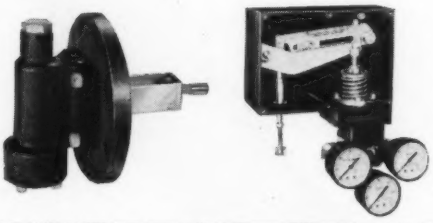

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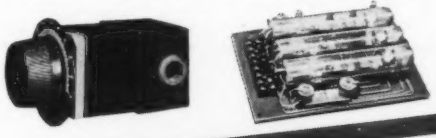

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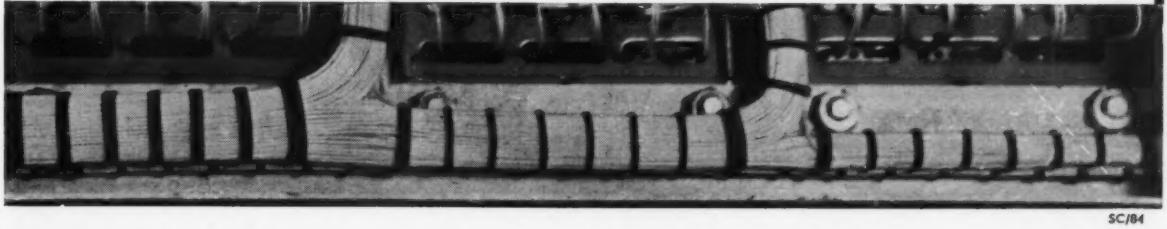

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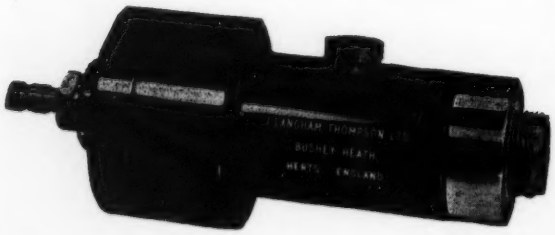

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INSTRUMENT Practice AUTOMATION & ELECTRONICS

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VOL. 13. No. 12

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INSTRUMENT Practice
AUTOMATION & ELECTRONICS

COMMENTARY

Computer Control and Data Processing Whilst no information has yet been released on a major computer-controlled plant in the United Kingdom, one is aware of developments proceeding both on full-scale and pilot plants. Pending the release of relevant data in this country, some recently-published American material on actual and expected computer sales for this purpose in 1959 and 1960 is of interest. Our United States contemporary, *Control Engineering*, in the November, 1959, issue, presents the following figures:

	Actual Sales to Sept., 1959	1959 *Total Sales*	1960 *Total Sales*
Computing-Control	24	25	28
Computing-Logging	20	27	50
Other On-Line Processing	8	10	21
TOTALS	52	62	99

The figures reveal one interesting trend. The data-logging equipment is approximately the same as the computer-control units for this year, but in 1960 the figure is nearly double, no great increase being envisaged for control computers proper. This follows the trend discussed in the article by Dr. Maddock in the September issue of *Instrument Practice:* "Trends and Developments in Instrumentation in the U.S.A.", in which the author considered that a rather cautious approach was being adopted to computer control. This is justified when one considers the relatively high cost of a computer. Dr. Maddock quoted expected improvements of 1-5% in efficiency if computer control is adopted. This means, at the moment, that only plants with a large output can be considered if cost recovery is to be obtained over a small number of years. But there is no doubt that those firms with logging equipment will be turning more and more to the computer-control aspect, and the predictions that this method of operation will begin to function more rapidly in 1960 in America seems to be justified by the above figures. 1960 should also see a parallel advance in our own computer-control installations, and the fields in which the first full-scale efforts will be made will be similar to those in America, i.e., oil production, general chemical production and electric power production.

E.F.F.I. Those initials stand for the Electronic Forum for Industry, the first bulletin of which is now published. It is mentioned, here, as the subject matter is that of data processing. The terms of reference of the body are wider than this particular field, but much of its deliberations are likely to be associated with the subjects discussed in the above paragraphs. This leads one to reflect on the number of bodies disseminating information on computer control and data processing. E.F.F.I. is one, of course, although this has eight trade associations as constituent members. On the society or institution side, we have the British Computer Society, Group B of the British Conference on Automation and Computation, the Institution of Electrical Engineers and the Society of Technology. Other institutions than those mentioned have promoted conferences dealing with the subjects in question, and publish relevant papers from time to time in their journals. On the one hand, this can indicate a healthy interest, but on the other hand, with no co-ordination, considerable overlapping can take place. It is to be hoped that there will be some form of consultation between the various bodies, otherwise saturation may easily occur both in printed matter and in conferences.

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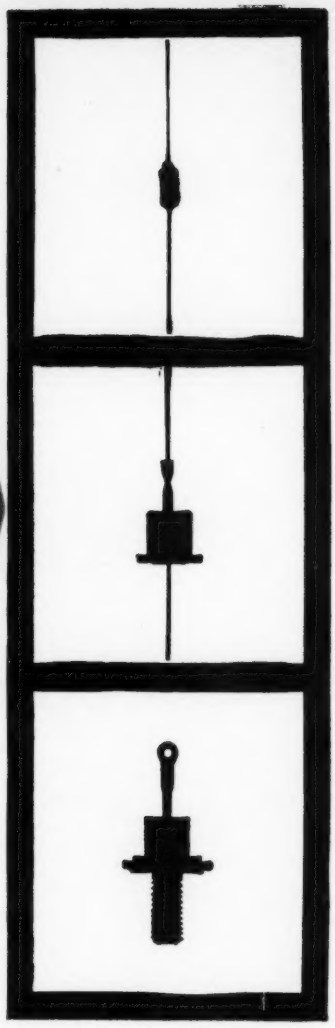

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Average Rectified Forward Current at +150°C	I_o	250mA	250mA	150mA	150mA	*1A	*1A
Recurrent Peak Forward Current at +50°C	i_f	†2·5A	†2·5A	†1·25A	†1·25A	*10A	*10A
Surge Current for 10 Milliseconds	I_{FM}	16A	16A	6A	6A	33A	33A
Operating Temperature, Ambient	T_A	−65°C to +150°C					
SPECIFICATIONS							
Minimum Breakdown Voltage at +150°C	V_R	240V	720V	240V	720V	240V	720V
Maximum Reverse Current at P.I.V. at +25°C	I_{R_b}	10μA	10μA	0·2μA	0·2μA	10μA	10μA
Maximum Forward Voltage Drop at +25°C	E_b	1·0V (I_o=500mA)	1·0V	1·0V (I_o=400mA)	1·0V	1·1V (I_b=1Amp)	1·1V

* Rectifier mounted on 2" x 2" x ¼" aluminium Heat Sink † @ 25°C

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A Temperature Monitoring System for Nuclear Reactors

By R. L. G. GILBERT, Ph.D.

Marconi Instruments Limited

Introduction

THE importance of instrumentation is steadily increasing as industrial plant becomes more complex. Early steam engines were equipped with a safety valve on the boiler, which indicated excessive steam pressure, and two boys—one to operate the steam valves to the engine, the other to lubricate moving parts. In due course, in order to improve the fuel consumption, a pressure gauge was provided, and valve linkage was introduced. Further refinements included pressure oil feeds together with oil pressure gauges, speed indicators and speed controls, exhaust steam condensers and exhaust pressure gauges. The introduction of the turbine tended to increase instrumentation still further.

Most of the instruments used on engineering plant serve only to indicate that the quantity being measured is within a safe working range. Usually a fully scaled indicator is provided, although there have been systems employing warning lamps to indicate fault conditions. The lamp indicators are not entirely satisfactory, as they give no indication of the extent of the fault—for example, in the case of an oil pressure indicator, lamps do not distinguish between complete failure of the lubricating system, and low oil pressure, although the action taken by the engineer in charge might well be quite different in the two cases.

The operator of a plant can readily assess the meaning and importance of a group of some tens of indicators; when the number of indicators rises to hundreds, his task becomes much more difficult, and when modern plant demands thousands of indicators, it may well be claimed to be impossible. One solution of the problem is to increase the number of engineers supervising the plant; another solution involves a re-assessment of the problem.

The Selection of a System

The primary requirement of instrumentation is to ensure that the quantities measured lie within a safe range; there is a secondary requirement which demands that the quantities can be measured and presented whenever required. In some systems it may be desirable to perform simple arithmetical operations on the quantities measured, so that factors such as safety margins can be shown. It may also be useful to memorise the information for a time, so that in the event of a fault occurring, all the stored information may be presented, and an analysis of the events leading to the fault can be made. A choice has to be made between an analogue and a digital system of instrumentation. The analogue system tends to employ fewer components, unless extensive arithmetic operations have to be performed, but it is difficult to memorise the information if the accuracy required is better than one per cent. The digital system, although using more components, does so in the form of basic interchangeable "building blocks" so that the complexity is not increased in proportion to the number of components. The accuracy of the digital system is limited by the accuracy with which the quantity being measured may be converted into a digital form; arithmetic operations can be performed with no loss of accuracy, and the output is usually presented in a digital printed form which does

not involve loss of accuracy. The final choice will depend on the relative importance of cost and accuracy.

The instruments will in general each be measuring one parameter, but no output will be presented unless that parameter wanders outside its prescribed limits. It is possible to use one "measuring system" to "view" a number of sensing elements, checking each in turn. The number of elements which may share one measuring system depends on the rate of sampling of the detectors and the maximum rate of variation of the measured parameters, but it is frequently possible to use one measuring system to scan several hundred sensing elements.

The complete system of instrumentation will consist of a number of units. The first will be the switching unit, which will connect the sensing elements in turn to the measuring system. The inputs may be digitised (in the case of a digital system) either before or after switching; generally digitisation before switching will be used if a detector is available with a digital output or if an integrated value of the measured quantity is required. Examples of two possible inputs are position indicators, which readily lend themselves to direct digitisation, and counted inputs, such as measurements of radioactive particles. After the switching and digitising units may come the "active" memory, if one is used; any arithmetical operations can then be performed on either current or past information, using the same arithmetic unit. The "active" memory unit will include a system linked with the switching unit in such a way that the origin of the information stored is known. A "static" memory unit will be used to store the reference levels which indicate the safe range of operation for each point of measurement; static and active memories may be incorporated in one unit or they may be separate. After the arithmetic unit will come the presentation unit, which will probably incorporate alarm lamps to indicate deviations from "safe" conditions, and a display which is capable of presenting all the quantities measured, probably at the normal scanning rate.

The rate at which the various sensing elements are scanned is influenced by a number of factors. Any given sensing element will be viewed by the system once during each scan; variations in the quantity being measured which occur in a period shorter than the scan period obviously cannot be detected, and this consideration usually sets the minimum scanning rate. A high rate of switching may create problems in the conversion from an analogue to a digital signal, and the switching unit tends to become more expensive as the rate of switching is increased. In most cases the maximum rate of scanning is limited by the output printer, although in some cases the analogue-to-digital convertor or the arithmetic unit might limit the maximum speed.

A Nuclear Reactor Temperature Measuring System

A case where instrumentation problems have led to the adoption of a scanning system is the measurement of temperatures in the reactor of a nuclear power station. The temperature of the reactor is measured at several hundred points, and each point has a particular safe maximum temperature. In general, the operator is not interested in the temperature of each point, unless it rises above the maximum permissible for that point; an indication of the working temperature of the reactor is presented on a few meters which are permanently connected to selected thermocouples. Under certain conditions, notably when some fault arises, the operator may want to know the temperature distribution throughout the reactor, either at the present time or during a period previous to the fault. The operator may also want to ascertain quickly the behaviour of one thermocouple over a period of time.

A temperature scanning unit has been developed by Marconi Instruments Limited with a view to its use in nuclear power stations. Six hundred thermocouples are distributed around the reactor, and the time constant of the reactor is such that a two-minute scan period is sufficiently short for satisfactory operation. The minimum scanning rate is thus five points per second, or slightly higher if "dummy thermocouples" are provided to check the operation of the system.

The output from the thermocouples at the operating temperature (400°C) is approximately 16 mV, and the temperature should be measured to within $\frac{1}{2}$°C, corresponding to 20 μV. The equipment should "load" the thermocouple as little as possible, so that any other instruments connected to the thermocouple are not affected. It is desired to compute the average rate of change for each thermocouple between successive readings, to check each thermocouple output for high alarm level, and the rate of change for excessive rates. This amount of computing, coupled with the accuracy required, strongly suggested that a digital system should be used.

The aim throughout the design has been to achieve a life in excess of 20 years, with a minimum of replacements and maintenance. The active switches in the scanning unit must obviously be protected from dust and oxidation to achieve such a life. Gold-plated uniselectors (preferably immersed in oil) can be used, but suffer from two drawbacks; the first is the life expectancy, and the second is their relative inflexibility. Relays can be used, if fitted with precious metal contacts, and sealed, but the electrical pick-up in a normal iron-cored relay may be considerable. The M.I. system uses a type of relay with completely sealed moving parts, known as a dry reed relay (see Fig. 1). When the coil is energised, an axial field is applied along the reeds, which mutually attract and close the electrical circuit. The contacting parts of the reeds are plated with precious metal, and the glass envelope may be evacuated or filled with any suitable gas. Six hundred double-pole relays are used to control the inputs, and the life expectancy is over 200 years. If it is desired to change the order of scanning the relay coil connections can be changed rather than the thermocouple leads, and the minimum of disturbance will

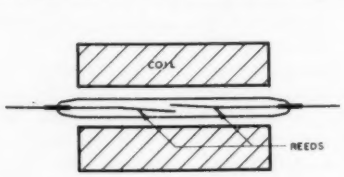


Fig. 1.
Dry reed relay

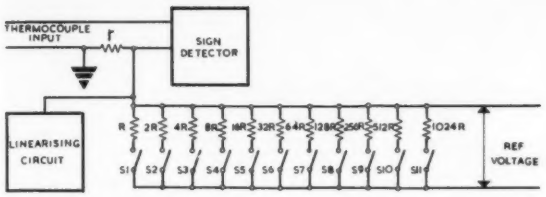


Fig. 2. Feedback unit

be caused to the system. In addition, it is possible to connect different thermocouples to two or more independent systems, with different scanning rates; errors due to loading of the thermocouples can be eliminated by using inhibiting circuits which prevent a thermocouple being connected to more than one system at a time.

The thermocouple voltage has to be converted from an analogue to a digital form, and it is desirable to make the digital output correspond to the Centigrade scale, although the thermocouple voltage is not quite linearly proportional to temperature. The accuracy of conversion from analogue to digital will depend upon a reference voltage, with which the thermocouple output is compared, and some form of multiplying or dividing device—usually resistances. It is usual when converting from an analogue to a digital reading to amplify the thermocouple voltage with a stable d.c. amplifier so as to raise the level of voltages being compared to a few volts; this introduces a new source of error—the gain of the d.c. amplifier, and it was considered to be much better to convert the thermocouple output into digital form without amplification. The system used is shown in Fig. 2. Eleven switches control the flow of current through eleven analogue resistances, as shown, and the total current then flows to earth through the analogue resistance r. The reference voltage is maintained across the analogue resistances, as shown, rather than between the supply line and earth, so that the voltage developed across r does not affect the current flowing through the analogue resistances. The sign detector is an amplifier which detects the sign of the voltage applied to its input, and gives full output for 20 μV d.c. input.

The digitisation of the input voltage proceeds in fixed time intervals; in the first interval, the switch S_1 corresponding to the highest digit (512°C) is closed, all others being open. If the thermocouple voltage is greater than the feedback voltage, the amplifier output remains as before and the switch is left closed; if the thermocouple voltage is less than the feedback voltage, the amplifier output changes sign and the switch is opened.

The second largest digit (256°C) is next turned on, and left on or switched off as required, and so on until the last digit (½°C) is reached. At this stage, digitisation is complete, and the positions of the switches indicate the digital measurement of the temperature.

The switches are shown as mechanical switches, although transistors are used in practice to achieve long life in the digitiser. The switching transistors are controlled by bistable transistor "toggle" circuits, and the states of the toggles indicate the digitised temperature. Linearisation of the thermocouple characteristic is achieved by feeding an extra current, which is not linearly proportional to temperature, into r from the linearising circuit. Chromel-Alumel thermocouples may be conveniently linearised by assuming that the characteristic consists of two straight lines, joining at about 330°C, and making the linearising circuit feed into r a current proportional to the difference between the measured temperature and 330°C, so long as the difference is positive. The maximum error caused by this approximation is 1°C, at 130°C, and the error is usually below ½°C.

The characteristics required of the sign detector amplifier are unusual. Clearly the zero level of the amplifier must not drift by more than the required accuracy—approximately 50 μV long-term and 20 μV in two minutes—but no great stability of gain is required, as a halving of the gain only means that the last but one digit gives the same effect as the last digit should—i.e., the resolution is reduced from ½°C to 1°C. Such a variation of gain is, of course, extremely high, and would not normally occur in practice. The amplifier is subjected to considerable overloads, and must recover from them quickly; if the temperature is 256°C, then the input to the amplifier (initially +10 mV) during the first digit period is −10 mV, recovering to +10 mV, and during the second digit period 0 mV. Clearly the amplifier must correctly respond to the minimum digit—i.e., 20 μV—to differentiate between 255½°C and 256°C, which means that it must recover from a 500-fold overload in one digit period, i.e., 10 millisec. In order to achieve the required stability and life, a transistor chopper amplifier is used, the a.c. amplifier section of which is directly coupled so as to enable the amplifier to recover from overloads rapidly.

The input impedance of the system is variable with time, and also depends on the input voltage. The input impedance of the amplifier is about 5,000 ohms, so that initially the input impedance is 5,000 ohms. During the digitising cycle, sometimes current will be drawn from the source but at other times current will be driven into the circuit. At balance, there will be less than 20 μV at the input to the amplifier which will produce a current of less than 4 mμA; this current may be of either sign, and is independent of the e.m.f. of the thermocouple.

The digitised reading is fed into the memory unit, which consists of a slow-speed magnetic drum, with 90 active tracks. Each track stores readings (each of eleven binary digits) from 220 thermocouples, and when one track is filled, the information is fed to the next. Three tracks are required for each complete scan of 600 points, so that 30 scans can be stored—i.e., readings during the previous hour. All arithmetical operations are performed on the readings stored on the drum, so that the digitiser is free to commence digitisation of the next thermocouple as soon as the current reading has been fed into the drum. The measured temperature is compared with its alarm values, which are stored on "reference" tracks on the drum, and alarms are raised if the temperature is above the high limit or below the low limit, the latter being used to detect faulty thermocouples. The present measurement is

next compared with the previous reading of the same thermocouple, to find which is the greater of the two—and hence whether the temperature is increasing or decreasing; the smaller of the two is subtracted from the larger to find the temperature change over the last two minutes, and the result is divided by two to give the rate of change of temperature in °C per minute. The rate of change is compared with its reference value and an alarm is given for a high rate of change.

The temperature and rate of change are now available as binary-coded numbers, and alarms have been given if appropriate. The output of the system is presented on a line printer which requires an input in decimal form, so that the binary number must be converted to a decimal number. This is carried out in two stages, by first converting to a binary-decimal number (i.e., each decimal figure is represented by a combination of 1, 2, 4 and 8) and then converting this into a decimal number. The first conversion is achieved by setting a binary counter to the measured value, and counting down by a train of pulses until the binary counter registers 0; simultaneously a binary decimal counter counts up from zero, so that the binary number is transferred into the required binary-decimal form. The binary-decimal number is then converted into a decimal form suitable for operating the printer by a diode matrix which energises one line out of ten for each digit printed.

The output printer will show the temperature, the average rate of change of temperature (with sign) over the previous two minutes, the thermocouple number, and any alarms which may be appropriate; this information will occupy one line of print. The printer may present this information as each point is scanned, to provide a routine record of the behaviour of the reactor, or it may be arranged to print out information only on the thermocouples which have given alarm signals. In addition, any thermocouple may be selected and all the values stored in the memory printed consecutively at five values per second. A block diagram of the system is shown in Fig. 3.

A system such as has been described involves a large number of components, and in order to ensure that there are no faults routine tests are built in. So far as is possible, sections are tested individually—e.g., the magnetic drum writing and reading circuits are tested five times a second, using the "spare" digit space (eleven digits are used for each digitisation, but twelve digits are provided on the drum for each thermocouple). In addition, every eleventh position scanned is a test point, when an input is fed into the system from a standard voltage source and potentiometer. Thus a series of "temperatures" are digitised, and the correct operation of the entire system can be checked; normal alarm signal outputs will of course be suppressed during the test intervals, and an alarm will only be given if the system (including the alarm circuits) does not respond correctly to the test input.

Alternative Uses

The equipment described may obviously be applied to any detector elements whose outputs may be conveniently digitised, such as thermocouples, strain gauges, pressure sensing elements, accelerometers, etc., in order to monitor routine operation. Another possible use for similar equipment lies in transient analysis, where inputs may be digitised rapidly (100 digitisations per second do not appear unreasonable), the information temporarily stored, and printed out at the maximum speed of the printer. The more complex type of instrumentation is superior to conventional recording oscilloscopes in three respects; accuracy is higher, it is possible to arithmetically combine information within the equipment, and records are digital (so that no scaling is needed). The equipment might also be used to control the transient whilst it is in progress, especially if alarm values are provided so that it is used as a safety control.

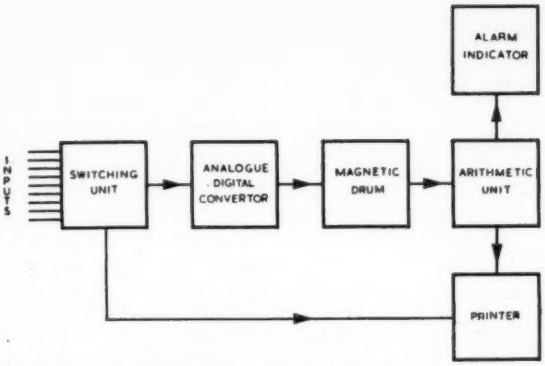


Fig. 3. Block diagram of temperature scanner

Conclusion

The evolution of instrumentation has been traced from the simple dial indicating instrument to the complex digital measuring and scanning system. The fact that digital measuring equipment has been evolved recently does not mean that it is necessarily superior to any other form, but rather that a new device is available which has some advantages and some disadvantages over other indicating devices. The main disadvantage lies in the cost of digital equipment, but a data handling system may be preferable to normal instrumentation where a large number of parameters have to be monitored, where accuracies of the order of 0·1% are required, where the result required involves some computation performed on the measurements, or where accurate measurements of transients are required. In most of the above cases the main advantage lies in the high accuracy and speed possible whilst maintaining a clear output presentation.

Acknowledgements

The author would like to thank the management of Marconi Instruments Ltd. for permission to publish this paper, and all those working at Marconi Instruments who have assisted in the design and construction of the prototype system.

Acknowledgement is also due to British Telecommunications Research Ltd. for their assistance in connection with the memory drum and associated circuits.

Cambridge Instrument Co. Ltd.

Opening of New Research Laboratories

THE Cambridge Instrument Co. first came into being in 1881 when the Cambridge Scientific Instrument Co. was founded by Horace Darwin and A. G. Dew-Smith. The company now has factories in London, at Finchley and Muswell Hill, as well as in Cambridge, and has associated companies in the United States and in Australia.

The company since its inception has pioneered the introduction of measuring instruments in industry, particularly for the recording and control of temperature and the analysis of gases. The recent expansions which have taken place in the company include a new assembly shop for gas analysis equipment, a building for the assembly of electronic recorders, and larger head offices in London as well as the new Research Laboratories which were opened on 14th October by the Rt. Hon. the Lord Adrian. All these developments indicate the company's intention to meet the requirements of science and industry and to maintain its position in the field of instrument research.

The new Research Laboratories consist of three floors and provide a working area of approximately 20,000 sq. ft. On the ground floor is the Mechanical Engineering Laboratory and the constant temperature room.

The Physics and Electronics Section is on the first floor. Among the exhibits was a **precision voltage measuring console** which has been developed in conjunction with the Sperry Gyroscope Co. The final destination of this instrument is the Woomera rocket range, where it will be used for the measurement of d.c. voltages up to about 48 volts with an accuracy of 1 part in 100,000.

Lord Adrian with other distinguished personalities examining the "Minican", a device for measuring the temperature inside a can.

Measurements are made with a precision potentiometer and are referred to the voltage of a bank of 12 standard cells maintained at a suitable temperature constant to within $\pm 0{\cdot}02$°C. Provision is made for inter-comparing the voltages of the individual standard cells to within 1 part in 10^6 and for measuring their temperature to within 0·01°C by means of a resistance thermometer.

A **12-channel oscillograph** for recording photographically, voltage, current and power waveforms was exhibited.

Light spots reflected from 12 galvanometers of the Duddell type are focused on the recording film or paper contained in a drum or magazine camera, depending on the recording speed and length of record required.

The drum camera is suitable for recording speeds up to 12 metres/second with a record ½ metre in length. The magazine camera is limited to speeds up to 2 metres/second, but allows a series of records to be made up to a total of 20 metres.

The galvanometers are interchangeable and may be selected to have characteristics suitable for various recording frequencies up to 10,000 c/s.

The oscillograph is provided with means for initiating transient phenomena, and with a time marker for recording 10, 100 or 1,000 millisecond intervals.

A selection of mechanical thermometers and controllers from the Mechanical Thermometry Division at North Finchley included an automatic control panel for a boiler installation, and the Thermograph programme controller.

Work is in progress on the scanning electron-probe X-ray analyser which was developed by the Tube Investments Research Laboratories.

Instruments from the Muswell Hill works included an electronic recorder/controller, and an in-line scanning recorder, and a wide range of electrical measuring instruments.

The Physical Chemistry Section showed a series of experiments concerned with boiler feed-water, determination of dissolved oxygen by electrochemical techniques, a hydrazine recorder, the continuous titration of oxygen, conductivity of dissolved carbon dioxide, and the measurement of pH.

On the top floor is the Design and Drawing Office.

The new Research Laboratories are linked to the existing factory buildings and the proximity of the main factory buildings has permitted the installation of ancillary equipment and boiler room in the basement of an adjoining shop.

Planning permission has been obtained for the building of an extension to the new laboratories when required.

Fig. 1. General view of the interior of the No. 3 Mill. On the right is the No. 13 machine. In the left foreground part of the refining system with the control room beyond. In the left background, the top of the super calender which stands on the ground floor.

Fig. 2. Squeeze clamp lift truck handling pulp at the No. 3 Mill. Pulp is conveyed to the hydrapulpers from a large storage area adjoining the mill along a high level platform, served by two overhead cranes.

Instrumentation in the Paper-making Industry

Part I—The Process

By L. A. LE BRETON*

IN order that the reader may appreciate some of the difficulties of instrumentation and control in the paper industry, it is as well perhaps to devote this first article to a brief discussion of the basic process of paper-making. This industry with its wide and ever-increasing range of products is one of the major manufacturing elements of the country's economy and mills may be found throughout the country, varying from small single machine factories to mills having 15 and 16 machines and occupying several hundreds of acres. One such as this is Aylesford Paper Mills of Albert E. Reed & Co. Ltd., whose factory covers an area in excess of 500 acres, of which over 200 acres are fully developed.

The modern paper machine is designed to operate at speeds of up to 2,500 ft/min, producing a sheet of paper over 20 ft wide and is probably the largest fully integrated unit of machinery to be found in the world. Fig. 1 shows a general view of the No. 3 Mill seen at first floor level. On the right is the No. 13 machine which has recently started production and which is the most highly and effectively instrumented machine of its type in the country. It produces 10 tons/hr of newsprint and magazine papers.

The basic constituent of paper is the cellulose fibre found in varying quantities in almost any form of vegetation and, indeed, papers have been produced from such diverse materials as grass, straw, bagasse (sugar cane) and linen. In the main, however, paper is made from the cellulose fibres obtained from timber, and it is because of this that the North American and Scandinavian countries have become the traditional home of the pulp and paper industry. Here the spruce and fir is found in abundance and has, moreover, a rapid and prolific growth.

Pulp Making

Generally the reduction of the felled timber to pulp, necessary for paper-making, is accomplished by two distinct methods.

Firstly, and by far the cheapest method, the fibres are obtained by a process involving the de-barking and washing of the timber prior to the application of powerful grinders. The product thus obtained, known generally as "groundwood" or mechanical pulp, is of comparatively short fibre length and its use may be appreciated later.

Secondly, the fibres are obtained by treating the wood chemically and dissolving the surplus matter with a sulphite compound in steam-heated "digestors". This process, which is more expensive than the grinding method, produces a far higher grade of pulp known in the industry as chemical pulp. There are, of course,

*Chief Instrument Engineer, Reed Paper Group.

other methods and processes to produce these fibres but it is unnecessary to consider these at this particular stage.

Some mechanical and sulphite processes are carried out in this country but, in the main, the pulp is imported, from the countries previously mentioned, in the form of semi-dry sheets closely packed and wired into bales of approximately 3 cwt each. The pulp yard shown in the background of Fig. 2 stores nearly 50,000 tons of baled pulp, and from details of the squeeze clamp lift truck, at the bottom right of the figure, the size of the bales may easily be judged.

Thus, production of paper in this country resolves itself generally into the reconstitution of this baled pulp, its preparation, blending, drying and finishing to meet the needs of the printing, packaging and allied trades.

Paper Production

In the production of paper the fibres, having previously been prepared, are conveyed to the machine in an equally distributed form of slurry or, more generally, "stock", which is then allowed to flow at a controlled rate on to a conveyor belt comprising a very fine wire mesh. From this, the excess water is removed leaving a matrix of fibres on the surface of the wire which, having a natural affinity one for another, form a sheet. Further reduction of the water content is effected by means of presses and the sheet, now being self-supporting, is conveyed through a bank of rotating steam-heated cylinders to the finishing end of the machine. In order that the end product shall be of even thickness or caliper and of uniform weight, it is essential that the ratio of fibre to water (the consistency) shall be of a known and constant value and all operations during the preparation of the stock are carried out with a view to obtaining this condition.

The first stage in the preparation is the reduction of the baled pulp into a slush in order to separate the basic fibres and, while there are many ways of doing this, the hydrapulper is perhaps the most modern method. This consists of a large cup-shaped bowl having at its bottom centre a conical, bladed rotor. The hydrapulper is first charged with a measured quantity of water and the bales of pulp, having previously been dewired, are conveyed mechanically and discharged into the bowl. A general view of a hydrapulper floor with a pulp charge ready on the conveyor is shown in Fig. 3. It is as well, perhaps, to note at this stage that the accurate dry weight of the bales is unknown and, since the pulp yard is invariably an uncovered area, their moisture content, nominally 50%, varies with climatic conditions, so that although close control may be exercised over the measurement of the initial water charge the consistency of the resultant slurry varies accordingly. This process is carried out batchwise, the batches being discharged into a holding or "soak chest" in order to simulate the original pulp condition.

Treatment of Fibres

At this stage, one could liken cellulose fibres to short lengths of rope, each comprising a number of strands laid upon each other to give a single strand appearance, and the fraying or fibrillation of the fibres is now carried out to produce the necessary properties of the finished sheet. As pointed out earlier, the sheet is formed by the natural affinity of the fibres when precipitated from the wet state, and this is effected to a greater or lesser degree depending upon how much the fibres are frayed or beaten. A long fibre, for instance, with little beating, produces a sheet of high mechanical strength while the short well-beaten fibres are used for papers of greater opacity and a denser medium. Again, there are many methods of reaching this condition but perhaps the most common are "beaters" and "hydrafiners". The former comprise a barred roll revolving over a stationary barred bed plate, the pulp suspension passing between the moving and stationary bars around a trough and between the bars again, this circulation being continued until the pulp is ready. The latter method is to pump the stock through the annular space between a conical barred rotor and its barred stator. The amount of work done on the stock in this method is adjusted by the lateral movement of the rotor within the stator casing.

This preparation is carried out on both sulphite and groundwood stocks which are then blended in the ratio necessary to produce a sheet having the desired properties, an example being newsprint which is composed of approximately 75% groundwood and 25% sulphite. During the preparation various additions are made to the stock such as colourings, fillings (clay), etc., in order to produce the necessary finish and thereafter the prepared stock passes through a series of cleaning operations before being passed to the machine.

As was mentioned earlier the pulp is initially reduced to a consistency of approximately 7½% and during the operations prior to reaching the machine, this proportion is reduced by the controlled addition of water to a consistency of approximately 1½%. Further measurement of consistency and therefore control is impracticable beyond this value, as will be described in the next

Fig. 3. General view of the beater floor in the No. 3 Mill showing pulp being fed into a hydrapulper by an automatic conveyor. Part of the Group's development programme, the mill and the No. 13 machine which it houses have cost a total of £3,000,000.

article, and the reduction of the consistency to the ½% necessary at the machine is obtained by a quantitative blending system.

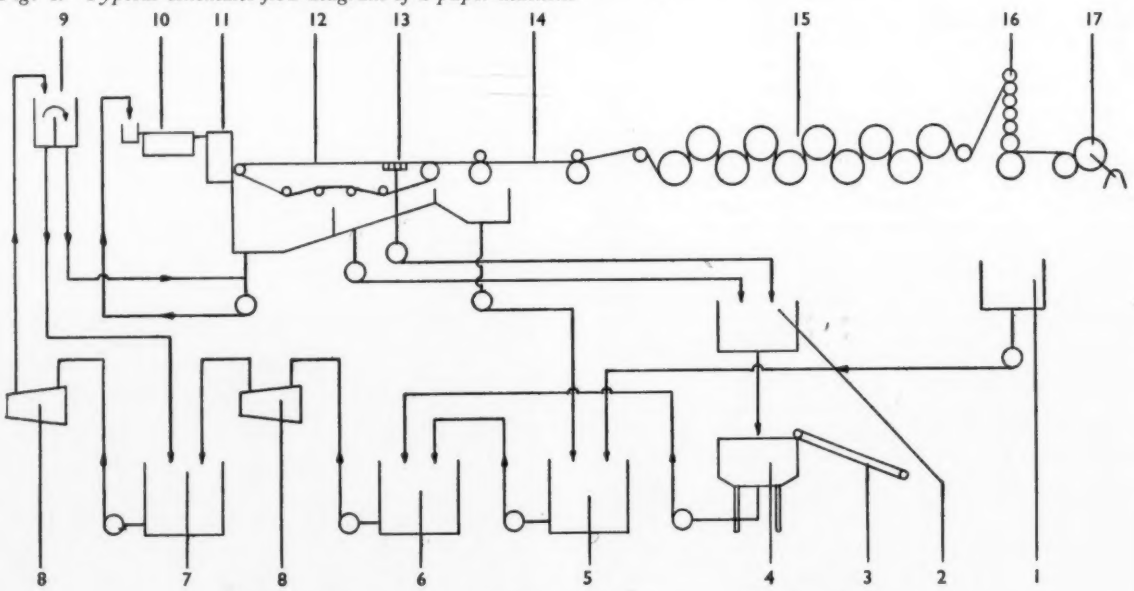
The stock is then fed onto the wire via a "flow box" and through the "lip", the latter being adjustable in order to discharge a variable quantity and therefore afford control over the basis weight of the final product.

Removal of the free water is effected whilst the stock is being conveyed on the wire by means of vacuum boxes over which the wire travels. The water removal thus obtained is insufficient to create a self-supporting sheet and a further moisture reduction is made by presses through which the wet sheet is now passed, a felt cloth being used as the supporting conveyor belt. From the presses the sheet is then fed through the drying section where it is maintained in close contact with the surface of the steam-heated drying cylinders, and control of the cylinder surface temperature is adjusted to afford a gradual moisture reduction to the desired value at the "dry end" of the machine. Finally, the sheet is reeled and leaves the machine for calendering, that is surface finishing and cutting.

Due to various causes such as tension, bubble holes, etc., breakage of the sheet is a frequent occurrence and, of course, the re-feeding of the paper, being a manual or manually-controlled operation, takes an indeterminate time. During a prolonged break the stock supply to the wire is cut off and the machine is stopped, but a paper break occasioned by minor causes is remedied while the machine is still running and during the re-feeding time the output of the machine is discarded at either the wet end or the dry end, depending upon where the break occurred. The disposal of this discard at the wet end is a fairly simple operation since the water content is still quite high and the material readily repulps. At the dry end, however, the sheet is now fully formed and the discard or "broke" of a large high-speed paper machine quickly reaches impressive proportions. In order to deal with this situation, it is usual to provide a broke pulper at the dry end either integrally with the machine into which the broke is fed immediately, or as a separate unit into which the broke is fed by hand. In both cases the resultant pulp is pumped back into the system.

This description is of necessity extremely brief and is intended only as an introduction in order that the problems associated with the application of process control may be more readily understood. The paper-making profession is still very much a craft and, with the many variables which can so very easily affect the finished product, running adjustments are made, even in the most modern paper mills, by paper-makers whose knowledge is based purely on experience. Indeed, the introduction of comprehensive process control in the industry has been necessitated only in the last few years with the advent of the higher speed machines and the succeeding articles will describe some of the developments peculiar to this industry.

Fig. 4. Typical schematic flow diagram of a paper machine



(1) *Broke pulper*
(2) *Backwater tank*
(3) *Pulp conveyor*
(4) *Hydrafiner*
(5) *Broke chest*
(6) *Soak chest*
(7) *Machine chest*
(8) *Refiners*
(9) *Head box*
(10) *Screens*
(11) *Breast box*
(12) *Wire*
(13) *Suction boxes*
(14) *Press section*
(15) *Drying section*
(16) *Calender*
(17) *Reel*

The final reduction of stock consistency is afforded by adjusting the flow of the stock over the weir in the head box and then blending this flow with the water from the wire pit.

G. E. C. Semiconductors

The General Electric Co. Ltd. is now producing approximately 70,000 transistors and diodes every week at its factory at Hazel Grove, Stockport. The factory became available for use by the G.E.C. in April, 1956, and in 1958 the company decided to form a Semiconductor Division to enable greater efficiency in the sales and production of semiconductor devices.

Apart from the production of germanium and silicon crystals, which are grown at Wembley, the bulk of the manufacture of semiconductor devices is centred at the Stockport factory. A general view of part of the factory floor in Fig. 1 shows some of the transistor assembly lines. The average production yield is between 70 and 80% with the yield on one device as high as 90%.

The basic principles behind the G.E.C. production techniques has been to determine which sections of the manufacture are vital from the point of view of cleanliness and to do those operations under known and controlled conditions. Fig. 2 shows the cold pressure welding of audio transistor cans in an inert atmosphere of nitrogen. This gives a permanent hermetic seal without the risk of damage or contamination to the device itself.

Until recently the thickness of the silicon and germanium wafers was measured using optical microscopes. The company's engineers have now developed a prototype wafer measuring machine (Fig. 3) which automatically sorts the wafers according to their thickness, and can deal with 1,200 wafers an hour.

Fig. 1. *General view of part of the factory floor, showing the assembly lines*

The wafers are placed in a hopper at A and from there are fed one by one past the measuring head B, where the thickness is determined in terms of a variation in capacitance. The meter energises solenoids so that the wafers are sorted into different trays (C) according to their thickness. There is a 4 micron discrimination between each tray. At a later stage counters will be incorporated in the machine so that there will be a record of the number of wafers in each tray.

Fig. 2. *Cold welding of audio transistor can in an inert atmosphere. A pressure of* 90 *p.s.i. is applied*

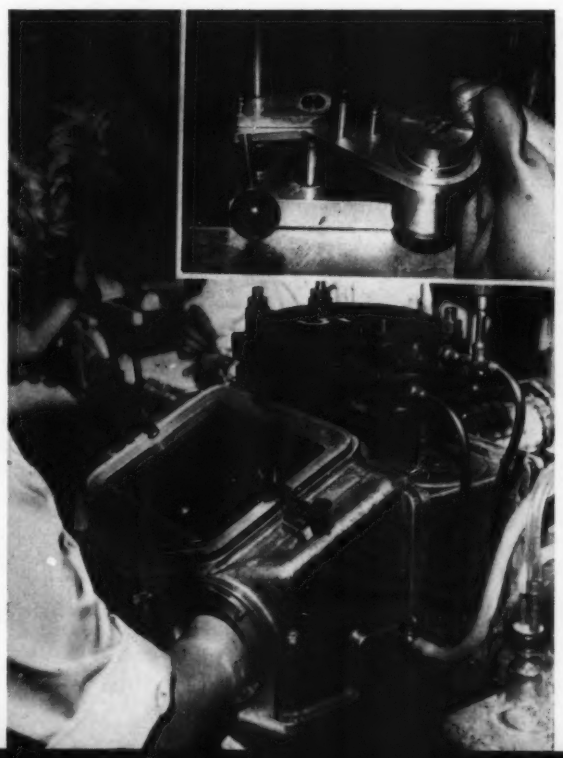
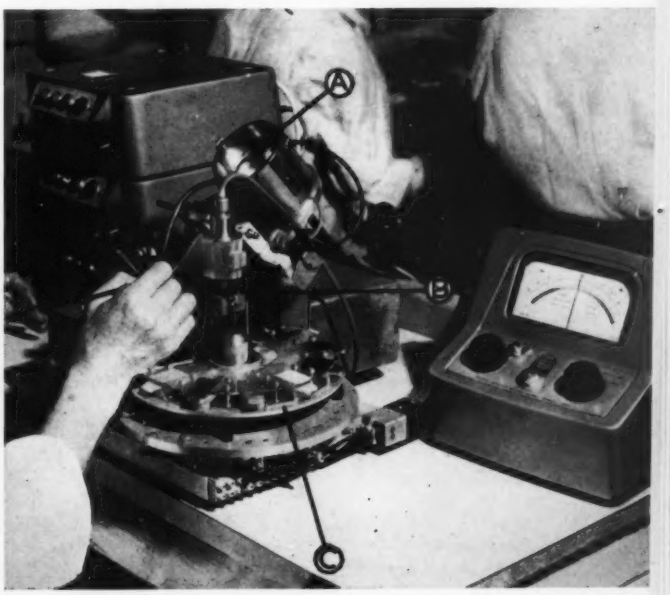


Fig. 3. *Wafer measuring machine which sorts germanium and silicon wafers according to thickness*



The Role of Instrumen

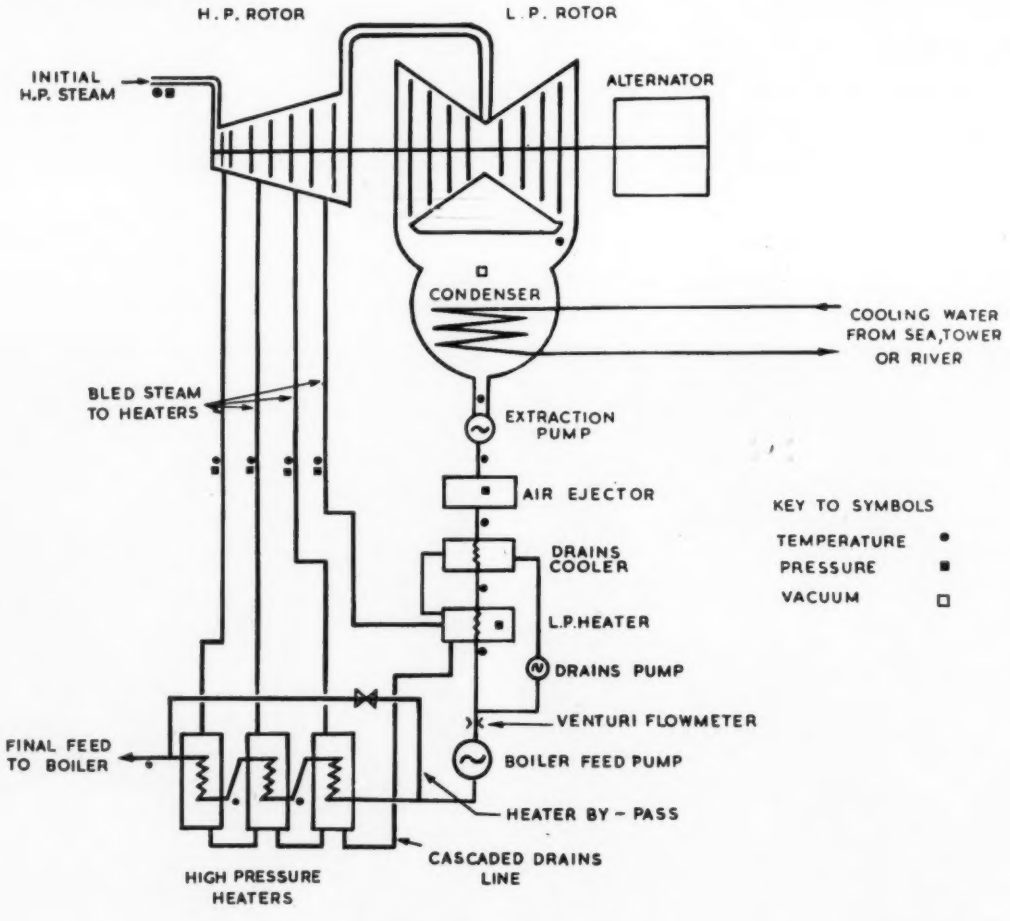
Introduction

THE fundamental measurements in any generating station are the quantity of fuel energy going in and the total electrical energy output. Much more information is required, however, if the plant is to be operated at maximum efficiency with maximum safety and minimum wear and tear. The advance towards higher thermal efficiencies has led to higher temperatures and pressures. To add to this turbines which 20 years ago were considered large if their capacity was 30 megawatts are now classed as small, having been superseded by 60 MW and 100 MW machines, with a 550 MW set in the advanced stage of design at the moment.

It can be seen then that large machines such as these will waste a considerable amount of heat representing appreciable sums of money if they are not operated under optimum conditions. Likewise the boilers supplying the steam can cause a very considerable financial loss to be incurred if they also are operated incorrectly. Apart from losses which may be incurred under normal operation, there is also the very great reduction in earnings if large items of plant break down and are out of service for long periods. This is particularly so during the winter months when the demand for electricity is greatest.

Instrumentation in power stations has also advanced considerably, and many new instruments have been

Fig. 1. *Basic instrument layout*



Power Station Efficiency

By R. L. CARPENTER
Instrument Engineer,
Portsmouth Generating Station,
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designed during the last decade to cater for the larger plant, presenting information which is of great assistance to power station staff in both operation and maintenance.

It is hoped that this article will show some of the part played by instruments in the generation of electrical power today.

Turbo-alternator Instruments

An overall assessment of the turbo-alternator performance can be obtained by measuring the total quantity of heat supplied, and the heat delivered as electrical power. For this purpose, the only instruments required would be a pressure gauge, temperature indicator, flow meter, and a watt-hour meter. However, since a turbine is quite a complex machine and employs a complicated steam cycle, these instruments would not be sufficient in determining which part of the machine required attention when a change in efficiency became apparent. In addition, there can be side effects on other associated plant through faults developing in the turbine steam/water cycle, and if these faults are not given early attention, the consequences can be serious.

Fig. 1 illustrates a basic instrument lay-out which would be found on a turbine for normal heat consumption calculations. The usual practice is for instrument readings to be logged hourly and, at the end of the week, averaged, and the figures obtained then used to calculate the efficiency.

Closer examination of the day-by-day readings can sometimes show up a fault or deterioration in part of the machine before serious trouble results. For example, a trend towards rising bled-steam temperatures over a period would indicate turbine blade fouling (build up of hard deposits on the blades), which results in a reduction of the stage efficiency. Adequate and accurate instruments are required if trouble is to be found in the early stages.

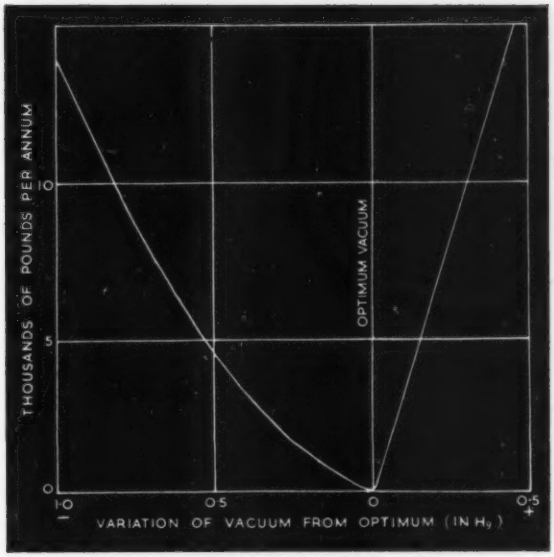

Fig. 2. Losses incurred for a 60 MW turbine operating with central steam conditions of 1,500 p.s.i. and 1,050°F

The turbine condenser is the source of the greatest single heat loss in the machine—over 50% of the heat supplied being wasted in this section. Unfortunately this has to be accepted, but careful observation of the vacuum and temperature can prevent much greater losses. The optimum value of the vacuum is part of the design considerations of the machine and losses are increased by variations from this optimum in either direction. Fig. 2 illustrates the losses incurred for vacuum variations from optimum for a 60 MW turbine operating with initial steam conditions of 1,500 p.s.i. and 1,050°F. It can be seen that if the optimum vacuum was 29·0 in. Hg, and the machine was run at 28·9 in. Hg, in the course of a year with the machine on continuous full load, the financial loss would be approximately £2,500. This illustrates the necessity of accurate vacuum measurement since a condenser defect such as tube fouling or inefficiency of the air ejector system which worsens the vacuum can be shown up by the instrument and remedial action taken.

Reference to Fig. 1 again will show that the instruments are concerned in measurement of temperatures and pressures only, but it would be wrong to assume that the information they present is only of use when analysed over a period of time. The turbine operator relies on his instruments to tell him that his machine is running correctly, enabling him to make necessary immediate adjustments to the plant if a deviation occurs.

Mention must now be made of other instruments not shown in the diagram but which are equally as important. Dissolved oxygen present in quantity in feed-water can have serious effects on boiler tubes working at high temperatures and pressures, the tube metals being corroded [1, 2] with consequent thinning of the material and the possibility of a burst tube. For this reason the feed-water is continuously sampled for dissolved oxygen, with the instrument sampling point

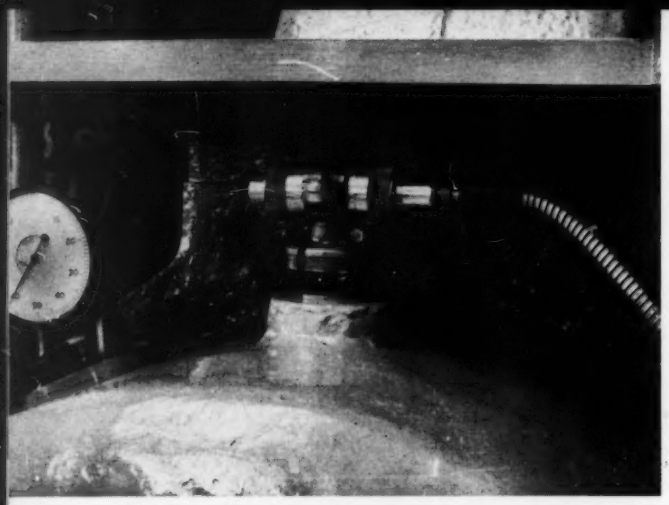

Fig. 3. Vibration pick-up fitted on a turbine high pressure rotor bearing

usually situated just before the boiler feed pump inlet. Thus all parts of the feed system which are below or near to atmospheric pressure where air could leak into the system are covered by the instrument, and the cause of any rise in the dissolved oxygen level can be traced without delay. The amount of dissolved oxygen present is usually very small—concentrations greater than 0·015 parts per million are considered high. Although this quantity appears insignificant it must be remembered that most large power stations operate 24 hours a day throughout the year and, therefore, in the course of this time the amount of oxygen carried into a boiler could be considerable.

It is well known that the electrical conductivity of water varies with the quantity of dissolved salts and impurities present in it, very pure water having a low conductivity. The purity of boiler feed water must be high, and modern water softening and treatment produces water with a conductivity of better than 0·5 micromhos per cm^3. Therefore, another instrument is employed to continuously sample the feed water and measure its conductivity. Contamination of the water causes scale to be deposited inside boiler tubes with consequent poor heat transfer and the development of hot spots. The most likely source of contamination is via leaking condenser tubes which allow impure cooling water to mix with the condensate, and for this reason the feed-water is sampled as early as possible after leaving the condenser.

A further check on the feed-water is made by measuring the pH value. As previously mentioned, the water is very free of impurities, and it is well known that pure water has a pH of 7·0, this being neutral. In such an unbuffered condition the water has a natural affinity to absorb chemical substances and thus the pH changes. This is illustrated by the absorption of CO_2 causing carbonic acid; $H_2O + CO_2 \rightarrow H_2CO_3$. Thus the water becomes corrosive and liable to attack boiler and turbine pipework[2]. However, there are several contributory factors to a pH value and a chemical analysis of the water is necessary before pH measurement can be of use. Having analysed the water, pH in conjunction with conductivity can be a useful guide to the quality of the water. New types of chemicals such as neutralising amines added to feed-water to prevent corrosion of pipework are becoming more widespread in use, with feed-waters tending to pH values between 8 and 9. The quantity of the additive is controlled by the pH measuring instrument which continuously samples the water.

In recent years a great advance has been made in the use of instruments to measure and record mechanical vibration and other stresses associated with running up turbines to synchronous speed and subsequent loading.

Before these instruments are considered, it may help if one reflects on the following points.

At some time the turbine will start from cold. Turbine inlet steam temperatures range from 800°F to over 1,000°F, and other machines are being designed for even higher temperatures.

Rotors are large, weights being in the order of several tons.

Turbine casings have to be thick because of the high temperatures and pressures.

The rotors run at 3,000 r.p.m. on load. Not all machines are run continuously throughout the year—those which produce the cheapest energy are continually loaded whilst others may only run for perhaps 18 hours a day, the more costly ones 12 hours, and so on down to the very small, very costly, old machines which may only run for the daily peak loads.

From the above it can be seen that metals are subjected to many stress cycles, and if insufficient attention is paid to the running up and loading of the machine, mechanical damage is inevitable. Under severe conditions of a bad run-up, damage to the extent of putting the machine out of service for several days or weeks could result. Normal practice in running up turbines to synchronous speed is to run the machine up as quickly as possible having due regard for its safety. In the past the operator had to depend on his experience, whether or not the machine sounded all right, and whether he could feel vibration. Consequently some operators were more cautious than others and would take a little longer.

Today, instruments record vibration, measure differential expansion between rotor and case, measure metal temperatures, and give the operator a picture of what is going on. The result of this is that run-up times are shorter with a consequent saving in heat, previously lost in excess drainage, and safety is increased.

A vibration pick-up fitted on a turbine high pressure rotor bearing is shown in Fig. 3. It is usual to fit one pick-up to each bearing and the instrument scans each in turn, the amplitude being recorded on a chart. A good machine will show better than 0·001 in.

Eccentricity of the rotor is measured since if this is excessive, bad vibration will result. One major cause of eccentricity is the rotor hogging between bearings during shut down. Although rotors are continually turned or "barred" during a shut-down period, some hogging takes place, which under careful run-up disappears.

Differential expansion between turbine rotor and casing can lead to very serious damage if allowed to rise unheeded, and for this reason instrumentation is provided to measure it. One method of doing this is by an inductive pick-up firmly fixed to the casing, the air-gap being varied by the lateral movement of the rotor.

Since the zero of the instrument will depend on the length of time the machine has been off load, provision is made for this, the pick-up being incorporated in a bridge measuring instrument with one arm being used for zero adjustment.

Finally, thermocouples buried in the casing give the operator some idea of how long it will take for the machine to warm up throughout. These thermocouples are placed in the top and bottom halves of the casing such that they are all at the same distance along the rotor, usually adjacent to the first row of blades. The couples are connected to a multipoint self-balancing recorder and from the traces the rate of metal temperature rise can be observed. Fig. 4 shows a thermocouple *in situ* in the top half of a casing. This particular couple is Chromel Alumel, mineral insulated, one eighth of an inch in diameter, and a tight push fit into a hole drilled in the turbine casing.

Fig. 4. Thermocouple in situ in the top half of a casing. The thermocouple can be seen entering the metal at the bottom left-hand corner.

Boiler Instruments

Of the total costs involved in the production of electricity, about 75% can be apportioned to fuel and fuel handling. It is obvious then that every effort must be made to use the fuel in the most efficient and economical way. Modern boilers with their high temperatures and pressures will generally return efficiencies in the order of 85%. Re-heat boilers, in which steam, having passed through one stage of the turbine returns to the boiler and is re-heated to a higher temperature but at a lower pressure than the original, return efficiencies of about 88%. At the moment there are only a few of these boilers in operation but it is most probable that the number will increase rapidly in the future.

It is well known that the combustion of any fuel yields large volumes of gases and that an analysis of these will show the extent to which the fuel has been burned. Since coal consists chiefly of carbon, hydrogen, and sulphur, measurement of the carbon-dioxide content of the gases is an immediate indication of combustion conditions. To this end, a sample of the flue gases is continuously drawn off and passed through an instrument of either the chemical absorption or thermal conductivity type which records and indicates the percentage of CO_2. If coal consisted entirely of carbon, and combustion was absolutely complete, we could expect to record a CO_2 of 21%*. But a normal coal may contain about 10% ash, 75% carbon, 5% hydrogen, plus sulphur, some oxygen, nitrogen and water. In addition, it is impossible in practice to obtain complete combustion of all the fuel. The CO_2 content of the flue gases will therefore be lower than the theoretical 21% and generally speaking a chain-grate boiler will give about 14% CO_2 whilst 16% CO_2 would be obtained with the more efficient pulverised fuel boilers. It must be borne in mind, however, that the composition of coals varies over quite a wide range and consequent upon this the power station chemist provides an analysis of the fuel enabling accurate efficiency calculation to be made. Coal for a particular power station may come from several different collieries and having been analysed once, the operating staff have a very good idea of the problems they may encounter in burning it, although each cargo is sampled by the chemist, because variations are found even in consecutive consignments from the same mine. Care must therefore be exercised when efforts are made to improve CO_2 values as undesirable effects can be brought about; an example of this being in a chain grate boiler where overheating of the furnace can result with possible collapse of brickwork. Temperatures must therefore be observed and these are considered in a later paragraph. A low value of CO_2 may be caused by either incomplete combustion through insufficient air or too much air which dilutes the flue gases. In the former case, black smoke is frequently produced which is indicated immediately on smoke density recording instruments, whilst in the latter case an abnormal rise in gas temperatures, particularly at the stack, will be observed.

Due to stratification in the gas stream it may be necessary to sample from several different parts of the boiler simultaneously in order to obtain a good representative gas analysis. Boiler losses increase rapidly as the percentage of CO_2 falls, and therefore accuracy in measurement is very important. In a boiler where the final temperature of the gas to the stack is 250°F, a reduction in CO_2 from 15% to 14% results in the boiler efficiency being lowered by 0·3%.

In recent years instruments have been designed which measure the residual oxygen content of flue gases. With this type of instrument greater control can be taken of the air required for combustion and, since it is always necessary to supply air in excess of the theoretical amount, determination of the residual oxygen enables the air to be kept to a minimum.

Closely linked to combustion is temperature measurement and for gas temperatures this is usually achieved by thermocouples placed throughout the boiler gas passes although in the combustion and superheater zones suction pyrometers are used in order to overcome the heating effect of direct radiation which an ordinary thermocouple would be subjected to. Apart from their use in normal boiler operation, they provide a means of detecting fouling and damage to brickwork and baffles. For example, in a final effort to extract heat from the gases, all air for combustion is passed through a preheater which is in effect a heat exchanger. Measurement of gas and air inlet and outlet temperatures gives an indication of the condition of the

*Volumetric analysis

preheater elements, these being subject to wear by acid action from sulphur and water vapour in the gases, as well as being fouled by small particles of dust.

Steam and water temperatures are also of importance and again these are obtained by either thermocouple or resistance thermometers. The steam outlet temperature is obviously important, and the water temperatures when used in conjunction with gas temperatures can be a good guide to the state of cleanliness or otherwise of the boiler, particularly the economiser.

A further aid is provided by the draught gauges which measure the pressure of the gases throughout the boiler as well as the pressure of the air for combustion. On a modern boiler upwards of a dozen gauges may be found recording pressures above and below atmospheric. All gauges are calibrated in inches of water with full-scale deflections ranging from about 1 inch of water to around 20 inches, depending on the design of the boiler and the location of the measuring point. One of the essentials for good combustion is turbulence in the combustion zone as this ensures thorough mixing with the air of volatile matter, and in the case of pulverised fuel, the particles of coal. Knowing draught conditions the operator can, if necessary, increase secondary or tertiary air supplies without causing the flames to impinge locally and create hot spots. Draught gauge indications along with gas temperature measurements will usually give a very good picture of the condition of the boiler interior, an increased or decreased temperature in one part will more than likely be confirmed by an abnormal draught indication.

The output of the boiler is obtained by measuring the rate of steam flow and is achieved by an orifice plate fitted in the main steam outlet. The pressure difference across the orifice can be taken directly to a recorder of the U-tube mercury manometer type, or applied to a differential pressure transducer fitted adjacent to the orifice plate, the electrical output of the transducer being taken to the indicating instrument. Feed-water flow is measured similarly. In both cases integrating mechanisms are fitted to the recorders since totals are required for efficiency calculations.

With the inclusion of pressure gauges, automatic fuel weighing machines and water level indicators, the instruments mentioned so far can be reasonably assumed to comprise the basic instrumentation.

Automatic control, however, is now included as a part of boiler equipment. For many years a large number of power stations have had an automatic control system of some type installed on some, if not all, boilers. Although these control systems are lacking in many respects by modern standards, they have proved their worth and contributed to the design and manufacture of the complex equipment controlling plant today. In some cases the control has been confined to only one item such as temperature, but in many power stations a complete unified system is installed controlling load, combustion and temperature. As mentioned earlier, a reduction in CO_2 from 15% to 14% causes a loss of approximately 0·3% in boiler efficiency. In a generating station consuming coal at the rate of 20,000 tons per week this represents a financial loss of about £240 in this time and here the advantages of fitting automatic control can be seen immediately. Temperature control can also effect considerable financial saving, the graph in Fig. 5 illustrating this. Again it refers to a 60 MW 1,500 p.s.i. 1,050°F turbine and shows the cost of temperature variation on the turbine over a year. Not only can a low temperature effect a loss in thermal efficiency, there is also the possibility of damage to the machine through sudden large temperature variations.

In common with most other process systems, three-term control is applied. Quite often the electrical demand on the alternator increases sharply, and under these circumstances the value of automatic control in maintaining stability of water level and temperature, while at the same time operating the boiler to meet the increased demand, can be readily appreciated.

Other Instruments

Many other problems arise from power station operation, although not necessarily on a day-to-day basis, which are worthy of mention since instrumentation plays a part in the investigation of causes as well as enabling the best choice of remedy to be made. Among these problems are: ultrasonic measurements to determine soundness of shafts and castings, internal inspection by eddy current methods of condenser and feed heater tubes to determine the extent of metal erosion; magnetic inspection of turbine blades for possible cracks; the use of water-cooled telescopic periscopes for observing flame characteristics in combustion chambers; and determination of stresses in pipework, supports, and pressure vessels by strain gauge techniques.

Training of Staffs

This involves both operating and maintenance personnel and is essential where new equipment and ideas are brought into use. The field of industrial instrumentation is relatively new, and to help power station staffs the Central Electricity Generating Board have in recent years organised courses in instrumentation for

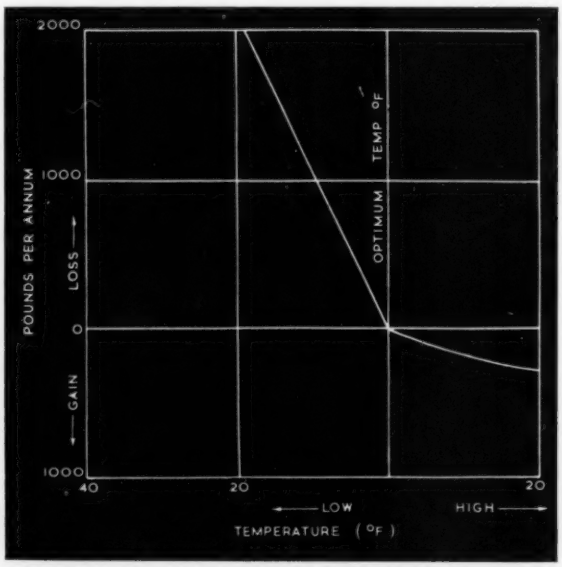

Fig. 5. Cost of temperature variation on a turbine over a year

maintenance and operation personnel. These have helped operators to a better understanding and interpretation of the information presented by their instruments, while at the same time encouraging them to believe that information. For maintenance staffs, the courses have been designed to encourage better accuracy as well as maintenance, thus providing the operator with a good service as well as confidence in his instruments.

Conclusion

Although it has not been possible to mention every instrument in use in a power station, the object has been to show that, along with many other industries, the generation of electricity is one in which instrumentation has progressed; the importance of instruments becoming daily more apparent. The advent of nuclear stations has made it quite obvious that the future power station staffs will have to rely entirely on instruments and to this end accurate and reliable measurements are essential.

Acknowledgement

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References

1. POTTER, E. C. Treatment and control of boiler feed water. New interpretations. *J. Inst. Fuel*, May, 1959.
2. HILLIER, H. Boiler corrosion and boiler feed water treatment. *Trans. Inst. Marine Engrs*, Jan., 1950.

KDP.10 Data Processing System

EXPERIENCE gained by the English Electric Co. in the application of the Deuce computer to specific sectors of the commercial data processing field led the company to undertake intensive studies to find the ideal form which such data processing systems could take. The projected system must be capable of handling, with maximum economy and efficiency, such normal problems as market research and forecasting, inventory and production control, cost accounting, payroll, sales and cost analyses, as well as such wider matters as statistical surveys and census studies. The object was to produce a system which was such a substantial leap ahead in concept and design that it would set an "ultimate" standard for several years to come.

The machine, which is to be built at the company's Kidsgrove works, is based on a design by the Radio Corporation of America, modified to suit manufacturing techniques and operational requirements in the United Kingdom and Europe.

The KDP.10 is a fully-transistorised data processing system consisting of a number of integrated units covering high-speed store, programme control unit, tape selection and buffer unit and a console with associated monitor printers and paper tape punch, a paper tape reader and high-speed printers.

The computer of the KDP.10 system is a general-purpose, stored programme digital computer which handles alpha-numerical information either serially or in parallel groups of four characters. An eight character two-address instruction code is employed. The first character specifies the operation, the next three characters specify the first address, the fifth character is used for automatic modification of the first and second address, and the remaining three characters specify the second address.

The high-speed store is a random access magnetic core device which provides storage for programmes and data. This memory can be easily expanded to meet system requirements within the range of 16,000/260,000 characters.

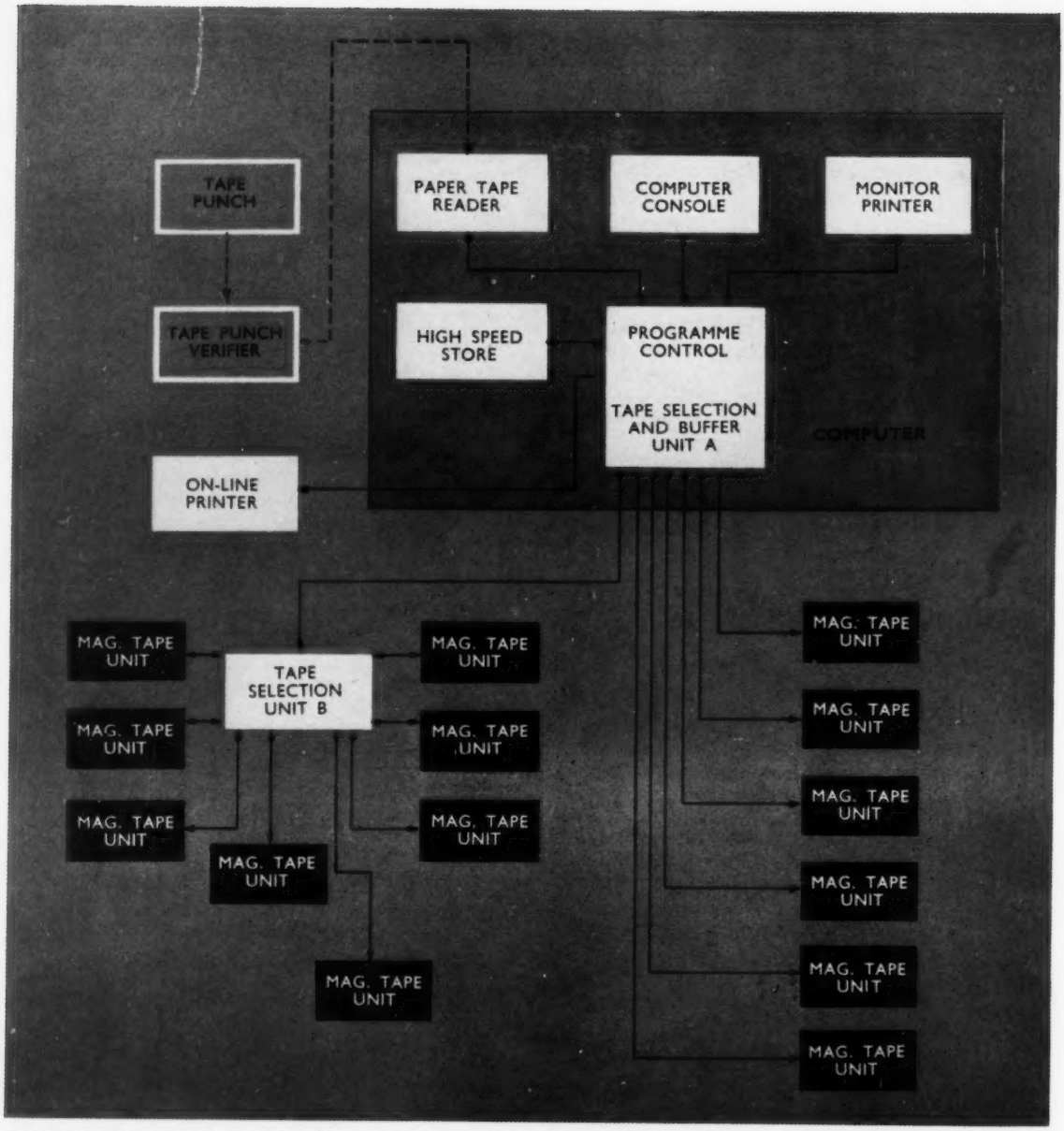
The programme control unit is the arithmetic and logical control element of the computer which interprets and executes the instructions of the programme stored in the high-speed store and performs the automatic accuracy checks.

The tape selection and buffer unit A allows for the connection of from one to eight tape stations to the computer and controls reading from and writing to magnetic tape on these stations. Programme instructions indicate the appropriate magnetic tape unit for input or output. It is important to note that the number of magnetic tape units directly controlled by the computer may be increased to 62 by connecting the tape selection unit B to each of the lines of unit A.

The console provides for the complete monitoring of the operation of the computer and the on-line equipments.

The monitor printer is an on-line device, somewhat similar to an electric typewriter, which prints on to paper from information received directly from the computer's store and is used primarily for programme operational control, programme testing and exceptional types of output.

Paper tape punch and tape verifiers are used for the original preparation and verification of the system coded 7-hole punched paper tape for subsequent input into the computer.



*K.D.P.*10 *Data Processing Unit—The programme control unit contains the arithmetic and control elements. The high-speed store is a random access magnetic core device. The console contains the control and indicating devices. A tape selection and buffer unit provides the necessary circuitry for inter-connection of up to eight magnetic tape decks. The paper tape reader accepts seven-hole punched paper tape. The monitor printer is an on-line unit, similar to an electric typewriter, and prints on to paper simultaneously with the preparation of paper tape. The high-speed printer, using edge-perforated paper, produces up to six copies at* 600 *lines, each of* 120 *characters, per minute.*

The paper tape reader accepts 7-hole punched paper tape and operates at the rate of 1,000 characters per second. It provides the high-speed input for initial programme insertion, programme testing and the insertion of periodically changing constants.

The main output is from a high-speed line printer operating under the control of the computer and producing up to six copies at 600 lines per minute; each line may have up to 120 characters.

The peripheral equipment includes a card transcriber, transcribing card punch, tape reader verifier and random access file. It is important to note here that in

many cases it is convenient to use punched cards for input and output of data; off-line card/magnetic tape and magnetic tape/card converters operating at 400 and 150 cards per minute respectively are available.

Accuracy Control

A number of automatic accuracy controls are built in at strategic points and are all designed to prevent incorrect information from entering or leaving the system.

Parity checks are carried out on all transfers of information within the system, including all magnetic tape and paper tape operations.

"Echo Back" signals are created in the recording heads when characters are being recorded on tape. These are parity checked at the tape unit and used to notify the user device (computer or card transcriber unit, etc.) that a successful recording has been made.

A similar "Echo Back" checking system is used in conjunction with the line printers.

The system uses dual recording on magnetic tape, the bits of each character together with a timing bit being recorded in duplicate in sixteen channels across the width of the tape. Either one of the two recorded spots for a single bit may be missing and the bit can still be read. If a parity error does occur during a read operation from magnetic tape a routine is automatically entered which causes the tape to be backed-up and re-read. The computer will stop if incorrect parity continues to be detected after a programme controlled number of re-runs and an indication will appear at the console.

All arithmetic calculations are performed in two separate ways and the results automatically compared. Any discrepancies will cause the computer to stop.

Any one of nine programme control conditions and twelve input/output conditions, automatically sensed, will cause the computer to stop. Separate indicators show immediately the location of the fault.

Representation of Data

Within the KDP.10 system data is handled in characters, i.e., as a direct representation of the original alpha-numeric information together with a number of punctuation and control symbols. There is consequently no loss of time or expensive special equipment required for conversion into binary notation. The internal representation has been chosen to allow complete checking of all arithmetic operations with a minimum of equipment while giving complete safety against the possibility of self-cancelling errors.

The system is readily adaptable to meet the requirements of both small and large organisations; for a smaller concern, wishing to allow for future growth, KDP.10 can be built up, unit by unit, in proportion to the volume of work demanded of it without altering the basic installation.

The company will deliver the system in mid-1961 and is carrying out systems investigations and feasibility studies in several branches of industry.

BISRA Open Days

THE British Iron and Steel Research Association held open days at its London Group laboratories at Battersea recently. The Plant Engineering and Energy, and the Ironmaking Divisions and the Physics, Chemistry and Operation Research Departments are all housed at Battersea and examples of many aspects of their work were displayed.

The Tallimarker

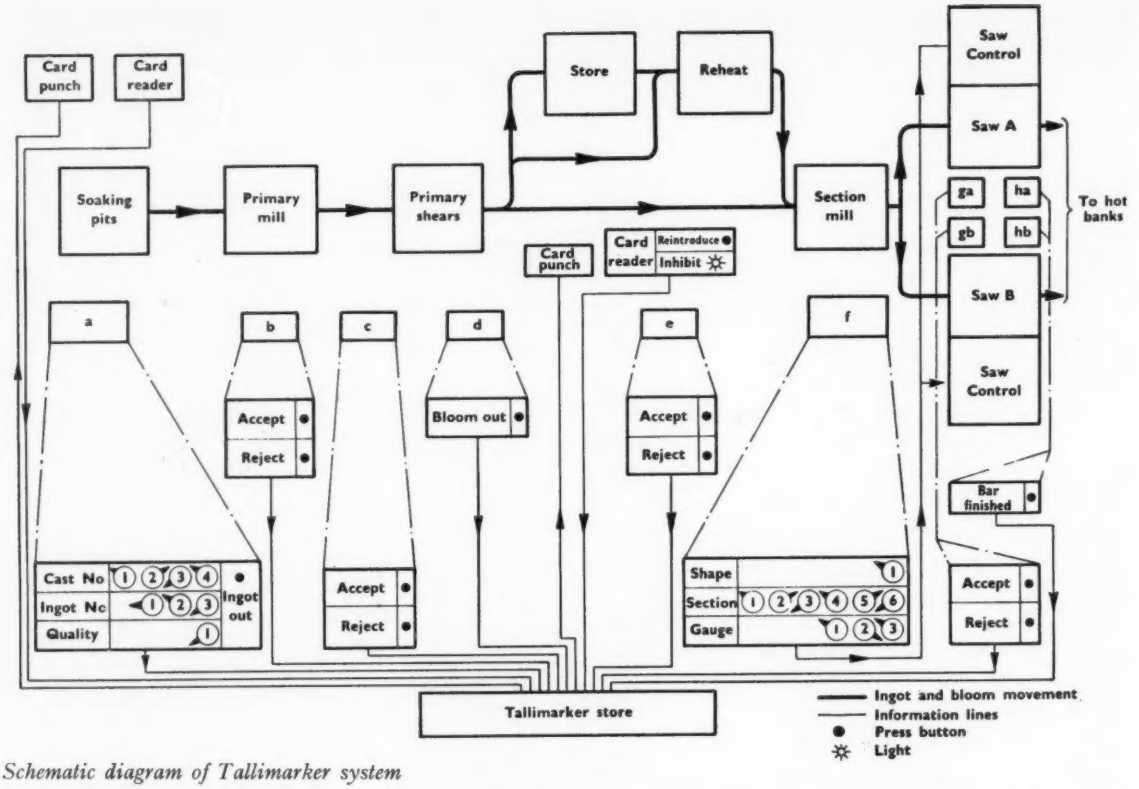
The Tallimarker system has been designed for conveying and recording information in steelworks. Information in a steelworks flows in two directions: details of a customer's order come from the mill office, and details of progress are transmitted back to the office where they are used in planning production, making up accounts and compiling reports for management. At present this information is usually passed on paper chits or by word of mouth—systems which are inefficient and consequently expensive. It is for this reason that BISRA has developed the Tallimarker automatic information handling system.

At the primary mill the ingot is rolled, in several passes, to a long bloom. This may be cut into as many as three shorter blooms at the primary shears. The shorter blooms travel on to the section mill to be rolled to the required section and gauge. These finished sections may be cut by either of two saws, A and B, into the lengths ordered by the customer.

After cutting, the sections are run out on to the hot banks to cool. At this stage each cut section must be uniquely marked and its full history made available.

During normal operation there will never be more than four ingots between the soaking pits and the hot banks at one time. However, it is possible that blooms from different ingots could be at the section mill and at both saws, so that the information about five ingots would need to be recorded at once. To give an ample margin of safety, therefore, the Tallimarker is made to accommodate six ingots.

There are eight stages (a to h) along the production line at which the Tallimarker must receive information and, when necessary, display the information already received.



Schematic diagram of Tallimarker system

At the soaking pits the cast number, ingot number, quality code number and bloom size required are fed into the Tallimarker store, and as soon as the ingot is on its way, "ingot out" is signalled. At the primary mill there are two possible signals, "accept" or "reject", which inform the Tallimarker whether the ingot which left the soaking pits has reached the primary mill or has been rejected.

Similarly, when the ingot reaches the primary shears it is accepted or rejected, and as each bloom leaves the primary shears the "bloom-out" button is operated. By counting how many times the "bloom-out" button is pressed the store registers the number of blooms cut from the ingot that was signalled as accepted at the shears. At the section mill a further "accept" or "reject" button is pressed in order to register the arrival of a bloom, and a second station at this mill is given information describing the section being rolled; for example, its shape, section and gauge.

The rolled section may next be passed on to either saw, and the pressing of the appropriate station "accept" button informs the Tallimarker not only that the bloom has arrived but at which saw it is to be cut. When the last piece of a section leaves the saw the "bar finished" button signals the removal of this section from the system.

While a section is being cut at a saw, the Tallimarker store holds the section's complete history, having followed it down the production line from the time the parent ingot left the soaking pits. Each time a length is cut from the section, the details in the store are relayed to the mill office and recorded in the most convenient form; for example, on a teleprinter record, punched card, or magnetic tape. The order number and the length cut are also recorded, and in addition are displayed to the cooling bank operators to assist in sorting the bars. After the last length is cut from each ingot the information in the store is erased.

Computer Applications

BISRA's Operational Research Department has investigated the advantages of installing a computer system in a production allocation office. The essential processing work in such an office can best be described as keeping a large order book up to date. Whenever necessary, information must be abstracted from this book in order to select suitable orders for the current production schedule, or to prepare advice notes and invoices. Cuts in office personnel to about one-third have been shown to be possible with the introduction of a computer system—only single shift operation need be anticipated and even then it would be unlikely that the computer would be fully utilised.

Investigations have been carried out by the Operational Research Department of BISRA to try to reduce the waste at the hot saw in a rolling mill. It has been found possible to feed the lists of customers' orders into an electronic computer, so that when the length of the good section available is fed into it by the operator, the

machine will select the best combination of lengths to be cut.

The problem of measuring the length of good section to the accuracy required is at present not solved very satisfactorily. The system could work quite well if the length were visually determined from a scale painted on the roller table, but methods for measuring the length automatically and relaying it to the computer are being developed, and when completed should enable the whole procedure to be made independent of manual operation. In a mill equipped with automatic saw bench length setting equipment the setting of the saw will be controlled directly from the computer; in other mills, the lengths selected by the computer will be displayed on a screen so that the sawman will be able to cut the lengths computed.

Trials of the selection process have been carried out on the BISRA *Pegasus* computer using actual works data. The wastage was found to average about 0·25 per cent when considering a maximum of five orders at a time. In practice, however, saws do not cut accurately to the nominal length, and tests have shown that a further 0·25 per cent must be allowed to cover against short lengths. Thus an average saving of about 1 per cent is possible with currently available equipment, so that with two computers (one for use as a standby when the other is being repaired or serviced) the annual saving in a 5,000 tons per week mill would be at least £50,000, even if the computers were depreciated over five years.

Instrument Section

Instruments in the steel industry for process control such as pyrometers, flowmeters and pressure gauges are well established; suitable instruments for product control, especially continuous control of dimensions of rod, strip and forgings and surface finish still need to be developed to help improve quality. Two optical strip width meters have been developed by BISRA, one of which was described in *Instrument Practice*, March, 1959, p. 277.

The continuous measurement of the reduction in gauge in the temper rolling of strip is still an unsolved problem. One approach is to compare the speeds of the strip before and after rolling; the increase in speed is, of course, directly proportional to the percentage reduction in gauge. Magnetic methods of measuring strip speeds have been tried but were found too sensitive to up-and-down movement of the strip in the neighbourhood of the measuring instruments.

BISRA is now developing a new method in which two photo-cells are sited on two illuminated spots on the strip surface. The two spots being a fixed distance apart and lying along the passline. Small irregularities in the light reflected from the strip surface give rise to a pattern in the output of the first photo-cell. After an interval of time, depending on the distance apart of the two photo-cells and the strip speed, another similar pattern appears in the second photo-cell. Thus, if the output of the first photo-cell is delayed (e.g., on a tape recorder) and then added to the second photo-cell signal, a maximum combined output will be obtained when the delay time introduced is equal to the time for passage of a point on the strip surface between the two photo-cells. From this delay time, and the known distance between the illuminated spots, the strip speed can be readily calculated.

A bar-section meter has been designed to measure simultaneously four diameters of hot solid bar at 45° intervals across the section while it is moving at high speeds. This information is valuable not only for checking that the section is being rolled to the specified size, but also for early detection of such defects as finning.

The water-cooled viewing head forms images from the opposite edges of the bar across each diameter to be measured. These images are combined in a single field of view, and are magnified and transposed so as to point towards each other. The instrument thus shows four parallel bands of light representing the four diameters measured. Each nominal diameter of the bar is set on the instrument by a micrometer adjustment; if this corresponds to the diameter being viewed, then the appropriate band is continuous across the field of view, i.e., the fact that the edge images have been brought to coincidence in any band indicates that the diameter is as set. If there is a gap in the middle of the band the diameter is less, while a bright central zone caused by the images overlapping indicates that the diameter is greater. First experiments show that deviations in diameter of about 0·005 in. can be detected.

The instrument is designed for mounting on a mill run-out table, the viewing telescope being offset to give convenient access. Guide rolls on the work-piece are necessary to keep it from vibrating when in the field of view.

The dimensions of large hot forgings cannot easily be measured by manual contact methods, since they are too hot (e.g., 1,100°C). BISRA is therefore developing an optical caliper that can be used from a distance of about 15 ft.

Each end of the forging is viewed through a prism. The two prisms are mounted on adjustable carriages; they can then be moved along a base line until the distance between them is equal to the distance between the ends of the forging. The images of the edge of the forging are combined in a single field of view, and are transposed so as to point to each other. When the edges of the two images coincide the prisms are correctly adjusted; if the images overlap or fail to meet, the prisms are incorrectly adjusted. The inclusion of a "telecentric" optical system ensures that accuracy is unaffected by distance between the instrument and forging.

The base line carrying the prisms is fully adjustable to allow the forging to be viewed from any direction. The image can be presented on a closed-circuit television screen and this has the advantage that the operator can view it from any convenient position.

Control Engineering

A large number of steelworks operations are now carried out by remote control. For higher productivity, improved product quality and greater reliability there appears to be more scope for hydraulic control systems. The hydraulic automatic gauge control system for rolling mills is an example of this.

(*Continued on page* 1257)

Leo computing system

By R. H. WILLIAMS, A.I.B., F.Inst.D.
Managing Director, Computer Consultants Limited

Computers and the Electronic Office

Part 6. A case history of a computer installation

Introduction

WITH the ever-growing volume of business which the companies of the Imperial Tobacco Organisation have to cope with and the general overall rising cost of catering for this growth, the directors early in 1956 turned their thoughts towards making use of electronic computers to carry out some of the administration and general office procedures.

During the war years, Mr. W. S. J. Carter, the sales director of the W. D. & H. O. Wills branch of the Imperial Tobacco Company Limited, had a personal interest in the development of electronics in other fields and was, like some of his counterparts in America, interested in making use of this medium for office work.

Like many other companies, the organisation carried out enquiries both in Britain and America to ascertain what equipment was available and which equipment was likely to best suit their needs.

During the visits they paid to America they saw procedures and organisations which were of interest, but they did not feel that any of these were in themselves outstanding enough to justify further concentration of study of American procedures, but rather that they should find out what was available nearer home.

In Britain they found that developments on computers had reached a stage where several companies were able to say that they hoped to have equipment available in two or three years' time, which could quite probably meet their requirements. The only company which was able actually to offer equipment which was already in use for somewhat similar purposes to their requirements was Leo Computers Limited, which is a subsidiary of the J. Lyons organisation.

An early detailed examination of the equipment which Leo Computers had to offer did however show that the existing system would not be quite adequate and there would have to be additional equipment and features incorporated. In particular, more internal storage space was required, and preliminary enquiries showed that this storage space could be made available in collaboration with Ferranti Limited, by the introduction of two additional magnetic drum units capable of storing about 100,000 alphabetic or numeric digits.

In addition, fast alpha-numeric printers were required to deal with the considerable volume of printing for despatch documents, invoices and statements. It so happened that the Imperial Tobacco Company had already placed one of the earliest orders for Powers Samastronic printers, and Leo Computers were asked to link these. The link was carried out with notable success and the quality of printing has steadily improved as modifications have been carried out to the printing mechanism as a result of operating experience. The quality is still perhaps not so high as that associated

with normal type-face printing, but it is certainly adequate and is continuing to improve as further changes are made.

Many organisations are understandably somewhat apprehensive about installing a completely new system, which may not be fully tried. The W. D. & H. O. Wills branch of the Imperial Tobacco Company, however, took the somewhat unusual step on this occasion of volunteering, and in fact asking their parent company to be allowed to act as guinea pigs in this experiment.

Experiment it indeed was from the point of view of their management, and it was this outlook, with the understanding which accompanied it, which in the early days of the work helped those responsible very considerably in their day-to-day activities.

Organisation of the Company

The company had built up over the years excellent customer relationship based on tradition to some extent, and had as part of its normal activities, and by means of positive customer relationship, established certain procedures which were helpful, as regards to organisation, both to the manufacturer and to his customer.

Among these were two important factors: one was the regularity with which their representatives called to collect new orders and cash due in respect of previous deliveries; the other was the paper work and order form design. This was such that the respresentative and the customer could readily decide on the order for fresh supplies, and furthermore could order them in such a way as to take full advantage of the manufacturer's best terms of business.

The firm of W. D. & H. O. Wills has a total of something over 100,000 regular customers in the U.K. and a feature of their trade is that normally the majority of customers order fresh supplies on each occasion when called upon by the representative. Approximately 40,000 are dealt with directly by the Sales Offices of the firm at Bristol. The representatives call regularly every five weeks and these regular dates of call are known in advance, and have previously been systematised into a coded pattern.

Another peculiarity of this business is that with a range of about 320 items, it is very seldom that any item is out of stock. Goods are despatched to customers by standard methods which are governed principally by the quantity of goods ordered, and the area in which delivery is required. Goods may be despatched either by goods train, passenger train, post or local van delivery.

The normal terms of business of the company is that one period of five weeks' credit is allowed in respect of goods supplied.

To those readers who have studied computer procedures the peculiarities and requirements which have been outlined above must surely present an ideal pattern for computer working. The fact is that these terms and arrangements for conducting their business had made it possible for this organisation to establish its business relationships, originally by manual methods and latterly by making use of Burroughs keyboard equipment, and they had and always could be relied upon to despatch goods promptly—the majority on the same date as the orders were received by the office concerned. One thing, therefore, was most apparent—that if computers were to be installed, no system would be acceptable which would not meet up to this high obtainable standard.

Computer Installation

Having taken a decision, in principle, in 1956 to install a Lyons Electronic Office, the company then established a team of its own on a joint basis, and composed of two members of the O. & M. department of the Imperial Tobacco Company and the O. & M. officer of W. D. & H. O. Wills, Mr. W. I. Allen, who later took complete charge of the installation.

The early studies made by this team showed that the plans that they had in mind appeared practicable. The order, which was placed for a Leo computer in January, 1956, contained a "break" clause which stated that the computer had to be acceptable to the investigating team. Work was proceeded with, and the computer proper was installed in September, 1958, after extensive trials in London and a demonstration to the company's board of directors and accepted very shortly afterwards.

It was realised at an early stage that one of the major tasks facing the organisation would be the smooth transfer from existing systems to the computing system and considerable thought was given to the method by which this could be accomplished.

The sales areas were already grouped into six districts. Plans were made to take over each of these districts in turn, and in turn again to take over a "dated" period of each district each day and each week. At the same time, in order to ensure continuity of smooth customer relationship, it was arranged that the work which was being taken over should continue to be done on existing equipment and run "in parallel" with the new system, until the five week cycle was completed

The changeover of the first district started in January, 1959, and at the end of five weeks the first district had been completely transferred. The work was literally being carried out twice, in order to check the correctness of the computing techniques. In practice, the errors and differences found between the two results produced were found to be errors which arose from the original existing methods.

So confident was the team in the ability of the computer to carry out the work for the changeover for the second section that it was decided to dispense with this duplication of effort entirely, and the changeover proceeded far more rapidly and smoothly for the second district than it had ever done with the first.

The changeover was in fact still continuing at the time of writing this article and the complete change was finished by 13th October, 1959, which was shortly before the end of the current financial year of the company. It will have taken in all a period of some ten months.

Procedures Handled by the Computer

The procedures which have been taken over relate entirely to the receipt of orders, the despatch of goods, the preparation and despatch of invoices, the preparation and despatch of statements, the receipts and

collection of cash and the accounting stock control of stock on hand.

At a later stage it is intended to use the figures prepared as a result of this work for analysis purposes for the guidance of management, but it is interesting to note that on this occasion the computer user concerned has concentrated on a "bread and butter" approach to the use of his equipment and has not gone in for some of the more sophisticated but doubtful reasons which are sometimes put forward to justify the use of computers.

Also, it is considered at this period in time, that the payroll of the firm can be carried out quite effectively with existing procedures. It is however eventually contemplated that spare computer time will be used for payroll computation as a secondary effort.

It must not be assumed that the firm did not place any importance on the necessity of producing adequate analysis figures for the use of management, but they felt that these figures must be those which management really required, possibly on an exception basis, rather than merely the production of figures for the sake of producing figures.

Also, without the production of the documents relating to the procedures mentioned earlier, intelligent use is already made of figures which are automatically produced by the computer. For example, on the order form sent to the representative, which indicates among other things the amount of cash to be received from the customer, there is also given detail of that customer's purchases, period by period, for the previous four periods, so that the representative may use his judgment as to what suggestions he should make to the customer as to future purchases.

Day-to-day Procedures of the Firm

The day-to-day procedures which are carried out by the firm upon the receipt of an order from the customer are traced in the following paragraphs, with a certain amount of simplification.

About 50 per cent of the orders are received through the manufacturer's representatives and the remaining 50 per cent are received directly from the customer, the majority on the manufacturer's pre-printed order form. Arrangement had been made however within the organisation to cater for orders received in any way which a customer may choose to use.

The mail is received through a special Post Office box number and is normally opened by 7-30 a.m. each morning.

The majority of the travellers' orders do not require any editing. The other orders are given a cursory examination and any serious exceptions are placed on one side for special attention at a later time in the morning, when they will not have delayed the processing of the main batch.

As stock is always normally available, there is no necessity when processing each order to enquire about the availability of stock.

The orders are then taken to the tape punching room where they are transcribed on to punched paper tape using a modified Creed Paper Tape Perforator, type number 7 P/N.

The tape produced by this machine is fed directly into a specially designed tape comparator, built jointly by Creed & Company and Leo Computers Limited. For the sake of clarity the first tape is a white one. The verified tape, which is prepared by another girl who perforates exactly the same information, making necessary corrections and adjustments, is coloured blue. Only blue tapes are processed by the computer.

Any cash received is indicated on the order form itself and is taken into the system by recording it along with the other information on this original order tape. Some cash is sent directly to the firm without orders and on these occasions special tapes are prepared and balanced with the Cash Department.

The traveller pays the cash he collects, directly into the firm's banking account. The other cash is balanced by the firm's Cash Office and part of the following computer procedures means ensuring that the amounts processed by this system and the amount received are reconciled and agreed daily.

It is interesting to note that in practice little difficulty is encountered in effecting this reconciliation which normally covers something in the order of several thousand orders per day.

It is possible, by dealing promptly with the receipt of mail and the preparation of input tapes, to start processing the work on the computer by about 8-15 a.m. each day.

As a result of this, it is possible to commence printing invoice sets on a Samastronic Printer. These sets each consist of four parts, each part of which is divided into two portions. When split into their various parts the following documents are available:

(a) Invoice for despatch to the customer
(b) Office copy retained for filing
(c) Up to four packing notes per order covering the despatch of goods from four warehouses
(d) Contents note for insertion with the goods.

Each of these documents contains a reference number which relates it to a particular customer. The customer's name and address is not produced by the computer as in this system this would be an uneconomic method of arranging the work, due to the very large amount of additional storage space which would be required. Also, under the system devised by Wills, the other ancillary documents, e.g., labels and consignment notes, are produced at the same time. If the computer was automatically producing the name and address it could also produce these ancillary documents, but not as cheaply.

The system at present used for adding the customer's name and address is by means of Addressograph plates. At the same time as the name and address is added to the documents mentioned earlier, the necessary number of labels are prepared, together with railway consignment notes, etc., on the special carrier's forms which are required for a particular method of despatch at a variety of points.

As soon as these despatch documents are ready, they are rapidly sent to the warehouse, the goods are packed and sent off promptly.

All orders are normally dealt with by the warehouse the same day as received with a very small amount of exception, which is cleared the first thing the following morning while the next day's despatch papers are being prepared during the first hour or so of the day.

Having dealt with the work described, the computer is then free to prepare statements and advices to customers, together with a fresh order form for the use of the firm's representative when he next calls. As mentioned earlier, this order form gives full details of the customer's orders for the previous four periods.

The installation of any computing system inevitably produces its crop of difficulties, but it would not be stretching the truth to say that the installation of this particular computer went remarkably smoothly. The equipment itself was brought into a fully commissioned state within 3-4 weeks of delivery and, as the main daily despatch and invoicing programmes had been fully tested in the Leo Computers works, it was able to start on parallel running very soon indeed after the packing cases arrived at Bristol. On certain occasions there was over optimism and under estimation of time required, but by and large the calculations of the team, as witnessed by the present success of the operation, did average out between the under and over estimating.

Maintenance Drills

Any large data processing system working for long periods of time can never be completely free from breakdown. This particular installation, at the moment, normally averages fifteen hours a day. A computer which is "on the air" for 90 per cent of its time when used for commercial work is generally regarded as acceptable. Leo at Wills works at times as high as 98 per cent—99 per cent and the average is of the order of 95 per cent effective time. This must inevitably contribute to the high success of the operation and emphasises the necessity of the effective preventative maintenance drills that have been worked out and the high efficiency of the maintenance teams themselves.

However, it would be foolhardy to design any system which is called upon to meet the very tight timing schedule outlined above, without providing some system which the organisation could fall back upon in the event of complete and lengthy breakdowns. Indeed, on one occasion, a stoppage which lasted eight hours occurred. This breakdown, which arose in the newly devised drum system—of which Wills were the first users in a Leo assemblage—followed a prolonged period of high reliability.

In order to meet this kind of stoppage it has been arranged that one of the cards processed and produced by the computer can be processed on equipment where the detail is transcribed into a readable ledger form. These cards are then filed and are available to be referred to in emergencies. Apart from this emergency availability, this method does present a random method of referring to details concerning a customer's account, when certain circumstances require this to be done.

The bulk of the original programming was carried out by the Leo organisation and it was found necessary to engage additional staff to form a nucleus of programmers for Wills itself. These new programmers joined the existing Leo team and then returned to Bristol to become the programming section of the Wills organisation.

They produced, jointly, programmes which enabled the work outlined to be carried out, but these programmes can still be streamlined and improved upon for many years to come as more sophisticated and better ways are found of carrying out the procedures. Programmes have not yet been written for some procedures which are to be carried out on the computer at a later date.

Benefits of Computer Installation

Finally, we have to define what benefits, if any, have in fact been obtained by making use of the computer.

On existing figures there is a measure of financial saving. As there will be little increase in the overhead expense of operating the computer on a third shift, it is anticipated that this will be much greater as more and more work is finally given to the system and existing work speeded up as economies are made in the programmes themselves.

Additionally, with sound fundamental planning and programming, the tangible saving which was touched on earlier in this article on the provision of more figures for management for the more effective control of sales will become a reality and will probably in itself be a very vital justifying factor.

(This article concludes the series on "Computers and the Electronic Office.")

(*Continued from page* 1253)

In the hydraulic system, which is being designed in the first place for the BISRA 14 in. experimental mill, the roll load is controlled by varying the force exerted by double-chambered, hydraulic capsules inserted one each side of the mill between the screws and the top chocks.

Each dual capsule contains a large (primary) and a small (modulating) chamber. Deformable rubber bonds connecting the two halves of each capsule seal off the chambers from each other and from the atmosphere. The primary chamber is connected to a storage vessel and filled with fluid to form a liquid spring, resisting compression of the capsule and providing an energy store. The primary chamber provides the major part of the roll load and the modulating chamber provides an additional load which can be controlled.

Variations in the roll gap cause relative movements between the two halves of the capsules and these movements are transmitted mechanically to the spools of the control valves. Compensation has to be made for the deformation of the mill components under load. This is done by a pressure transducer which gives a mechanical output proportional to the load and resets the linkage to the control valve.

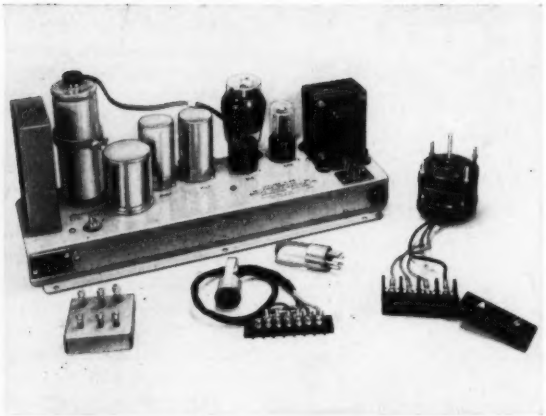
A constant pressure system maintains a 5,000 lb/sq. in. oil supply to the control valves each side of the mill.

Preliminary tests on the capsules and pressure vessels were made in the 14 in. mill, using a flying micrometer as a means of measuring gauge and an electro-hydraulic valve for control. The present tests are being made in a simple press to simulate variations in incoming strip, to test both the hydraulic system and the mechanical linkages, before installing the complete system in the 13 in. mill.

Circle 99 for further information

LEEDS NORTHRUP

SERVO KIT



THE Leeds Northrup Servo Kit, which is now offered for sale as a separate unit, is identical to that which has been fitted, for many years, to our well-known Speedomax range of Recorders.

IT comprises a 4-stage Resistance capacity coupled Amplifier which has in its input circuit a synchronous converter "chopper" which converts the D.C. signal to an alternating current signal at mains frequency, together with the Servo Motor and the necessary terminal blocks and plug connectors for the amplifier, and spare parts. It can be used in a variety of Servo Mechanisms where a D.C. input is available for the Amplifier and a Motor of this size is suitable for driving the mechanism itself.

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Top-it-up

THIS unit is designed for the provision of solid-free water for sterilisers. Its purpose is to prevent deposits on syringes and surgical instruments during sterilisation. Essentially this deioniser consists of a plastic base with tap water inlet and a mixed-bed exchange cartridge with top outlet for the purified effluent. Once connected to tap, the TOP-IT-UP provides solid-free (deionised) water instantly at tap speed.

Effluent costs are negligible. Exhaustion point is shown by a colour indicator. The Elgalite cartridge service applies to this unit.

Cost of the TOP-IT-UP: £28 0s. 0d.

Circle **1** *for further details.*

Short-circuit-proof Transistor Power Supply

THE AS.870 stabilised transistor power supply has a maximum output of 30 volts at 3 amp and is rated for continuous operation at temperatures to 35°C. It is provided with switched decade type controls which permit instant setting of output voltages to within one-tenth of a volt throughout the 30 volt range.

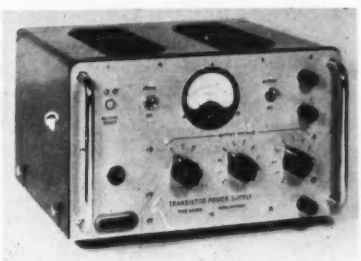
The combination of very low d.c. source resistance and an inherent high stability factor ensures output voltage deviations of less than 20 millivolts when switching from zero to maximum load conditions (or vice versa), even in the presence of concurrent mains variations of up to ±7%.

The AS.870 power supply is provided with two independent overload protection systems which assure complete protection for the unit under all operational conditions. A sensitive circuit breaker protects against normal overloading, while a special monitor/blocking circuit provides instant protection should the output be directly short-circuited.

Heat sinks have been designed to ensure that the semi-conductor elements are always operated well below their maximum ratings.

A floating output technique provides full isolation from both chassis and earth, which allows two or more units to be series connected for increased maximum output voltage, with no degrading of specified performance capabilities.

Circle **2** *for further details.*



AS.870 transistor power supplies

Electric Motor for Vibrating Drives

AN electric motor specially designed for vibrating drives, the first of its type to be made in the United Kingdom, is being produced jointly by The English Electric Company Limited and the Grantham Electrical Engineering Company Limited.

The completely self-contained unit provides a reliable drive by eliminating all the mechanical parts associated with an eccentric shaft arrangement. Vibration is generated by out-of-balance weights at either end of the motor which can easily be adjusted by single bolts to give the required output.

It is of robust construction, having heavy duty bearings with special features to deal with out-of-balance loads. Tests have shown that a bearing life of many thousand hours can be expected. The bearings are lubricated for life.

The motor is totally enclosed, dustproof and weatherproof. The frame is of nodular cast iron, with integral feet, and the shaft is of high tensile steel to withstand the high centrifugal forces to which it is subjected.

Because of its vibrating motion, the motor must be mounted on a resilient base. Operating at 1,500 r.p.m. synchronous speed, it has a power output of up to 7,500 lb centrifugal force, or 10,000 lb at 3,000 r.p.m., which is ample for all applications at present envisaged. The motor is operated from a 3-phase, 50-cycle supply at 110-650 volts. Greater outputs and other supply frequencies can be provided for.

It is built to B.S.2613, having Class "E" insulation on the windings, which permits a temperature rise of 65°C in a surrounding temperature of 40°C.

It can be used wherever a vibrating motion is required. Typical examples are drives for conveyor, screening, hopper and continuous drying systems (especially those for dealing with loose material in bulk quantities), tamping equipment (e.g., for pre-cast concrete) and machines for breaking or grinding down material into smaller parts, from materials as heavy as granite to those as light as plant leaves.

Circle **3** *for further details.*

X-ray Equipment for Aircraft Inspection

THE apparatus consists of four main parts: the extended rod anode tube; a high voltage generator (which can be used at up to 150 kV when deep penetration X-rays are called for); a control table incorporating all control, regulating and measuring instruments; and a water cooling pump for the head of the rod. The rod anode can emit X-rays at 360 degrees and will operate in a space approximately 5-9 in. wide.

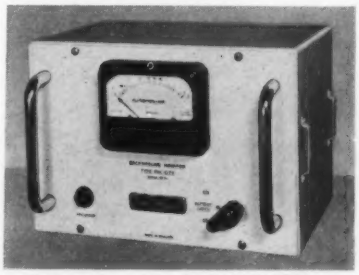
Circle **4** *for further details.*

Portable Background Monitor

A NEW lightweight portable monitor (Type PNI.1072) has been designed and developed by Plessey Nucleonics Limited, of Northampton, for the measurement of background radiation.

Detection is accomplished by a built-in halogen-quenched Geiger Müller tube with measurement on a transistor ratemeter giving direct reading of dose rate on a 2½ in. scale moving coil meter. The instrument has a range of from 0 to 3 milliroentgens per hour on a two decade quasi-logarithmic scale, with a minimum scale calibration of 30 microroentgens per hour. The unit is powered by a 9 V dry battery and weighs 8 lb.

Circle **5** *for further details.*



Background monitor Type PNI.1072

"Eel" Quantitrator

THIS is designed to meet the requirements of all those concerned with the complexiometric titration of large sample volumes. The instrument, which incorporates a magnetic stirrer, plugs into the "Eel" Unigalvo Type 20 on which readings are indicated.

A burette clamp and support is also available. Provision is made for the introduction of different filters from the spectrum range and beakers varying in capacity from 25 up to 600 ml. may be mounted on its platform.

The instrument will be of particular interest to analysts concerned with the water hardness test in accordance with British Standard Specification No. 2690.

Circle **6** *for further details.*

Data Monitoring and Logging Equipment

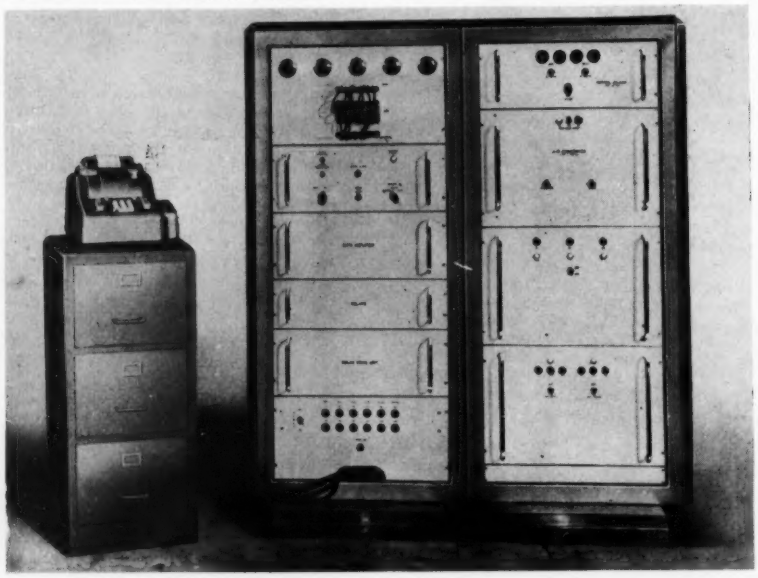
THIS equipment has been designed for use with continuous process plant, to monitor automatically information regarding plant performance. It will detect faulty conditions should they occur, or log the data for research and development purposes.

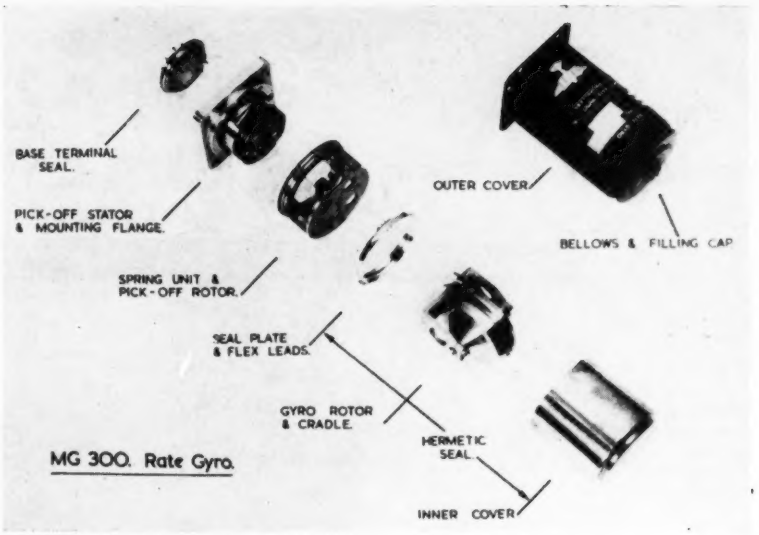
The input signals which are derived from thermocouples, pressure transducers, flowmeters, etc., are scanned repetitively. The voltage representing each input parameter, after amplification, is compared with a pre-set upper and lower limit. In the event of any parameter departing outside the pre-set limits the condition is detected and aural and visual warning given. The faulty parameter is digitised with three decimal digit precision (an accuracy of $\pm 0{\cdot}1\%$ full scale) and recorded by an in-line printer, or tape punch which also indicates the identification of the parameter and the time of the faults.

The equipment can also log all the data at pre-determined time intervals on demand, or continuously.

Circle **7** *for further details.*

Data monitoring and logging equipment





de Havilland miniature rate gyro MG.300

MG.300 Rate Gyro

THE rotor is driven by a hysteresis motor, synchronous at 24,000 r.p.m., and is energised by 26 volts 2-phase at 400 c/s. The motor stator can be wound to suit other supply voltages, but with the above supply the power consumption is 2·5 watts at a power factor of 0·5. The motor is sealed in an inner cover through which the motor leads pass via a glass-to-metal seal. The rotor itself was designed to have as large as possible a ratio of polar moment of inertia to inertia about a diameter, in order to give the gyro good frequency response characteristics. The angular momentum is $9{\cdot}6 \times 10^4$ g cm²/sec.

The spring unit with its pick-off armature attached also takes the place of the normal gimbal, as the rotor assembly is completely supported by it. The spring is extremely stiff in all planes, while allowing rotation about its axis, so that acceleration forces on the rotor assembly produce negligible errors in output. The pick-off armature is riveted to the spring end plate and is also used to limit the angular movement of the spring.

The pick-off is a variable reluctance bridge with four poles and is normally energised with 2·4 kc/s, 80 volts (mean). The current taken by the pick-off is 55 mA.

The gyro has an undamped natural frequency of 140 c/s. Damping is provided by silicone fluid which fills the gyro apart from the sealed motor compartment. The gyro is normally operated in ambient temperatures between 20°C and 100°C which gives a damping factor variation of between 0·8 and 0·13. The gyro, however, will operate down to a temperature of −70°C.

Circle **8** *for further details.*

Lunrac Standard Rack

THE Lunrac is rigidly constructed from 10 gauge formed steel sections.

Made to a depth of 19 in. for standard panel mounting, it is available in single or multi-bay assemblies. Hinged rear door and quick release side panels make for easy accessibility and the rack may be floor mounted or on castors.

The price is £38 10s. 0d.

Circle **9** *for further details.*

MV 300 Accelerometer

THE MV 300 accelerometer has a sensitivity of 25 volts full-scale output, and thus has wide application in telemetry and vibration work. A selection of models is now available whose sensitivities range from 0·5 to 8·0 volts per G when working into a 0·5 megohm load, with natural frequencies from 137 to 34 c/s.

The seismic mass of the instrument is a laminated armature which forms the moving part of a differential transformer a.c. pick-off. The armature is supported

by a leaf spring system, geometrically similar to Watt's straight line mechanism, which ensures rectilinear motion for the centre of gravity and virtually eliminates cross coupling errors and the effects of transverse accelerations. The overall hysteresis is less than 0·7% of the amplitude and cross coupling errors are less than 0·2%. Stops, capable of withstanding very high shock loads and sustained overloads of the order of 100 G, are fitted.

An internally mounted demodulator and filter unit, potted in epoxide resin, is fitted and provides a d.c. output voltage with low ripple content.

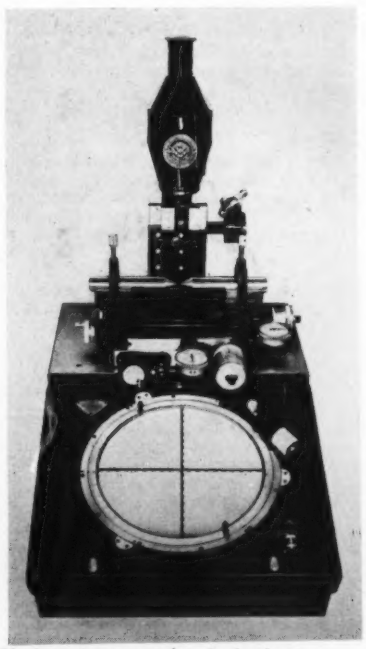
The instrument is intended for use between −60°C to +100°C, but is tested beyond these limits during manufacture to determine the stability of the zero error. The maximum zero error is 1·5% of full scale and its maximum temperature coefficient is 2·5 mV/°C. Normally a sensitivity tolerance of ±5 per cent is adequate, but for special purposes this figure can be reduced. The temperature coefficient of sensitivity is less than 0·02%/°C.

Provision is made for the adjustment of both zero error and sensitivity externally should the instrument suffer accidental damage; this simplifies repair work, the case being a completely soldered unit. These adjustments are performed by changing the values of miniature fixed resistors.

Circle **10** *for further details.*

Shadomaster Protractor

THE vernier protractor is for use with the standard Shadomaster projectors, models VMP, CRP and CRP Mk. II. It consists of a rectangular cast frame 15 × 12 in. with a rotatable circular screen 9¾ in. diameter



Shadomaster measuring protractor

In use, the normal etched glass screen is lifted out of the projector screen frame and replaced by the protractor. An adjustment is provided so that the protractor may be set parallel with the traverse of the workstage.

Circle **11** *for further details.*

Electronic "Building Bricks"

MULLARD EQUIPMENT LTD. has introduced a comprehensive series of electronic subassemblies designed as standard "building bricks" for the construction of industrial control systems, digital computing elements, data processing equipment, measuring systems and other equipments based on digital circuit techniques.

Two ranges of sub-assemblies are available: "Norbits" and "Combi-Elements".

The range includes all the appropriate circuit elements for the construction of machine tool and transfer line controls, factory safety systems, automatic lift controls, sequential programming systems and so on.

To ensure a high standard of reliability both the "Norbits" and "Combi-Elements" are transistorised throughout. They reduce power consumption, simplify the problems of heat dissipation and avoid the need for high voltage sources. Both types of sub-assemblies are, in fact, designed for operation from 24 V supplies, derived if necessary from batteries.

"Norbits": Building Bricks for Industrial Control Systems

"Norbit" building bricks are specifically designed so that the entire planning and construction of an industrial sequence control system can be carried out by the firm's plant engineer with no more than a very general knowledge of electronics.

Their assembly into complete systems has therefore been reduced to the simplest possible terms. The units have long flying leads so that inter-connections may be made without intermediate tag-panels of additional wiring, and using solderless clinched joints. Channel units, equipped with terminating blocks for input and output connections, are provided on which a number of Norbits may be mounted by single screw fixings. Comprehensive data are supplied with every unit which give, in addition to a general introduction on the use of Norbits, detailed information on performance, function and operating characteristics.

The basic Norbit unit is a transistor switching element which, in the interests of simplicity and flexibility, has been designed for use as an AND or an OR circuit, depending on the manner of connection. On receipt of information from the machine's limit-switches or other input sources, this switching unit performs the necessary logic operations and delivers signals in the correct sequence to a suitable output unit, which in turn activates the transducers governing or monitoring the functions of the machine. The basic unit measures 2½ × 1 $\frac{9}{16}$ × ½ in., and twelve can be accommodated on a single channel.

A number of output units of various ratings up to 150 watts are available for operating contactors, electromagnetic clutches, solenoids, etc.; other units include a counter, and a timer with a range of 0-60 sec.

"Combi-Elements": Building Bricks for Digital Systems

The range of Combi-Elements includes flip-flops and other multivibrator circuits, pulse shapers, gate circuits, amplifiers, and emitter follower circuits.

Each circuit is hermetically sealed in a small plastic case measuring only 2·1 × 0·94 × 0·39 in. and designed for quick, easy mounting on a printed circuit board using the same techniques normally employed for mounting resistors and capacitors. The physical proportions of the units are designed so that the maximum possible number can be accommodated on a single board.

The range of circuits has been based on the principle of d.c. gating and in general the signal transfer from element to element is at d.c. levels. The flip-flops and other multivibrators can be triggered by either a d.c. signal or a voltage step (a.c. signal) and, depending on the application, the units can be used for non-synchronous or synchronous logic, the latter using clock pulses.

Circle **12** *for further details.*

Beryllium Monitor

THIS automatically-operated mechanical air sampling equipment has been designed by Glass Developments Ltd. for the United Kingdom Atomic Energy Authority. The equipment is suitable for handling six samples per hour, presenting them to a recording ultra-violet emission spectrometer capable of analysing a liquid solution. The sample is submitted to several processing phases before it is passed to the spark-chamber.

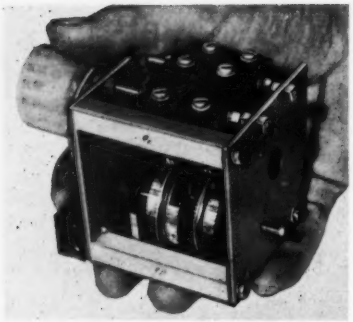
In operation, 100 litres of air are sampled every 10-12 minutes. The range is 0·25 to 25 tolerances (1 tolerance is 2 microgrammes per cubic metre) and readings are presented on a strip chart recorder. The principle of measurement is solution of the dust in sulphuric acid and analysis of this solution with an emission spectrograph. With this method, errors due to the chemical state and particle size of the dust are avoided. The monitor will function automatically and continuously for 10-hour periods without any attention. Audible and visible alarms are operated if the beryllium concentration exceeds a pre-set level. Interlocks are incorporated and also operate the alarms.

The two carbon electrodes are ejected after sparking and the new ones dispensed from magazines into the spark-chamber. All the operations are controlled by sequence controllers.

To avoid corrosion the acid fumes are extracted from all the operating positions of the dish and discharged through a chemical filter. The magazines hold 50 dishes and 50 of each type of electrode, sufficient for 10 hours' operation. The acid needs replenishing after about 100 hours. The monitor is mounted on a trolley and may be moved easily. Its width of only 20 in. enables it to be used in narrow passage-ways.

The monitor is used for aerosols other than beryllium and can be modified in several respects. It can for example be adapted for the semi-continuous analysis of other liquids and the chemical processing may be adapted to the problem in hand.

Circle **13** *for further details.*



Heavy duty miniature cam timer

Heavy Duty Miniature Cam Timer Type ZX

THE switching capacity is 15 amp at 250 V a.c. and 3 amp at 440 V a.c. Each timer is supplied with continuously and independently adjustable time setting cams. Time setting dials as shown in the photograph can be provided. Overall dimensions of a unit with two changeover switches are $2\frac{3}{4} \times 3\frac{1}{8} \times 5\frac{1}{4}$ in.

Timer ZX can be supplied with 1-12 changeover switches. Timers with a large number of changeover switches can be quoted for as specials.

The standard operating voltage is 220/250 V, 50 c/s, 1 phase a.c. or 400/440 V, 50 c/s, 1 phase a.c. These timers can also be supplied for operation on 110 V, 50 or 60 c/s, 1 phase a.c. For d.c. operation a d.c./a.c. conversion unit can be supplied providing a.c. output to drive the miniature synchronous motor.

The cam shaft speed of the timer Type ZX can be between one revolution in three seconds and one revolution in 28 days. At higher shaft speeds smaller numbers of switches can be operated. At cam shaft speeds slower than one revolution per minute up to twelve switches can be operated without increase in the size of the miniature motor.

Timers Type ZX are supplied either unmounted or mounted in sheet metal, cast aluminium, watertight or flameproof enclosures.

The prices range from £5 18s. 0d. and delivery of small quantities is 3 to 5 weeks.

Circle **14** *for further details.*

Metrix Universal Bridge

THE Metrix Universal Bridge Type 626 is a comprehensive instrument for the direct measurement of a wide range of values of resistance, capacitance, inductance, power factor and Q, at 50 c/s, 1,000 c/s and with an external source up to 10 kc/s. For resistance measurements, d.c. excitation is also supplied.

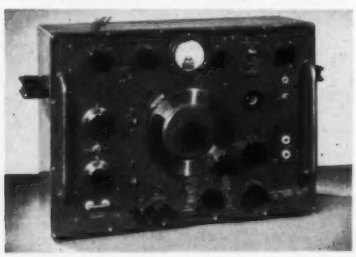
A separate, adjustable and metered d.c. supply is incorporated for the measurement of incremental inductance, and electrolytic capacitors may be measured with up to 500 V d.c. applied.

In addition to the bridge circuit, the instrument includes a 1,000 c/s oscillator and selective amplifier combined with a magic eye as a null detector. This offers the advantage of constant sensitivity over the whole range without risk of overloading the null indicator. A ring modulator allows the use of the amplifier when the bridge is excited by d.c.

In addition to direct measurements, facilities are provided for the connection to external standards or reference components so that the instrument can be used as a comparator bridge if required.

In order to reduce manipulations to a minimum and for ease of operation, careful consideration has been given to the general layout of the instrument and to the rational grouping of the controls.

Circle **15** *for further details.*



Universal bridge Type 626

Relay Tool Kit

THE Meter, Relay and Instrument Division of English Electric has assembled the relay tool kit, consisting of a contact gauge, burnishing tool, spring setting tool, inspection mirror and torch, and ring spanner.

The contact gauge determines the contact operation force in grams. Two leaf-gauges are provided, giving values of two and ten grams per division.

A flexible burnishing tool for cleaning is attached to the contact gauge and consists of a strip of metal, the surface of which is roughened by etching so that it has the effect of a very fine file. If used, abrasive material may result in the burning of contacts and the depositing of insulating particles on their surfaces.

The flexible burnishing tool can be compressed between them, which ensures that the actual contacting points are cleaned. Being flexible, it is useful for cleaning contacts located in normally inaccessible positions.

The spring setting tool can be used to adjust tool contact gaps to the required setting. The contact springs are bent at their clamping point so that kinking and deformation of the springs is avoided.

The size 2BA-0BA spanner fits the hexagon-headed nuts and bolts.

Circle **16** *for further details.*

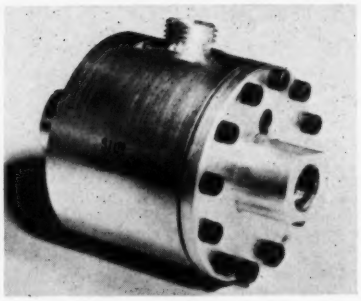
Nylon Plug and Socket

AN extremely small plug and socket in nylon, the Harwin W.3000/3001 can be mounted at only $\frac{5}{16}$ in. centres. Its gold-plated contacts will carry up to 7·5 amperes at 750 volts, contact resistance averages 2 milli-ohms, insulation better than 10^6 megohms. Working conditions up to 100°C can be tolerated and vibration and impact resistances are good.

Circle **17** *for further details.*

Differential Pressure Gauge

DIFFERENTIAL pressure gauge Type G.255 employs a variable inductance sensing element for use with Southern Instruments f.m. amplifier system.



Differential pressure gauge

Pressures can be applied to either, or both sides of a beryllium copper diaphragm; movement of this diaphragm is detected by an inductor cast into the body of the unit. The voltage output from the f.m. pre-amplifier is strictly proportional to the difference in pressure on the side of the diaphragm. Linearity is better than 3% of rated range.

Ranges: 1-0-1 p.s.i. to 1,000-0-1,000 p.s.i.
Dimensions: 2·25 in. dia. 2·82 in. overall length.
Weight: 21 lb (0·9 kg).

Circle **18** *for further details.*

LP.55A Polarograph

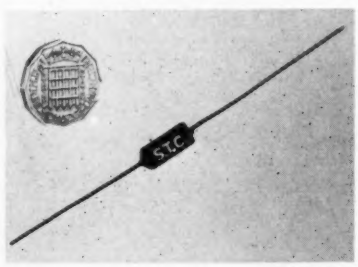
THE KOVO LP.55A polarograph is a photographic recording instrument of a type not manufactured in the U.K. A sensitivity of 0·1 μA full-scale deflection is obtained by suspending its galvanometer on a cantilever three feet above the instrument. Operation is motorised and fully automatic, once the voltage range that is required to scan has been set on the instrument. Automatic recording of abscissae after every 100 or 200 mV is performed, so that the photographic record can be easily evaluated. Approximate size is 18 × 13 × 11 in.

Circle **19** *for further details.*

Silistors

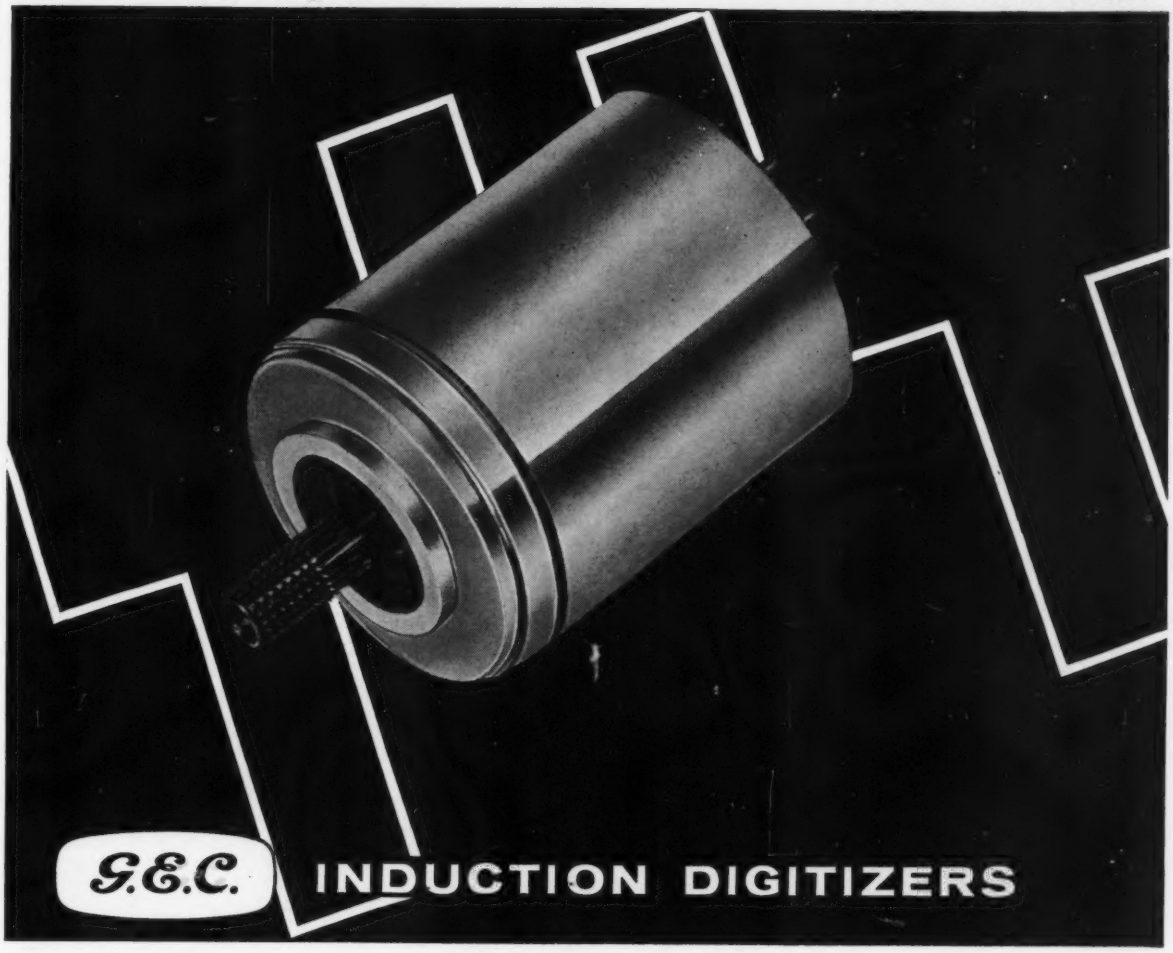
THIS is the name of silicon resistors with a positive resistance/temperature coefficient. Their temperature coefficient is 0·77%/°C at 25°C, with a maximum operating temperature of 150°C and minimum operating temperature of −60°C. The maximum dissipation up to 35°C is 1·5 watts. A 0·25 watt silistor having a dissipation constant of 2·3 mW/°C is under development.

Circle **20** *for further details.*



Silistor

Circle 100 for further information



no slip rings
no commutator
no photocells

THIS ENTIRELY NEW type of transducer, for use in digital data handling and computer systems, gives a numerical representation of the position of a shaft or slide in the form of coded electrical signals without the use of slip rings, commutator or photocells.

Basically the digitizer is a transformer with a single exciting winding and a number of secondary windings corresponding to the number of digits. The position of a moving yoke determines the polarity of coupling between the exciting winding and the various digit windings, which are arranged to conform to the requirements of the code. Either pulse or sine wave excitation can be used.

Shaft digitizers can be operated in coarse/fine combinations, an additional winding preventing ambiguity between the digitizers. Instruments can be supplied for 5-digit read-out in a size 11 standard synchro housing. The coding may be either in a binary form (type LB5-3) or in decimal form (type LD5-2). Other types of digitizer, e.g. those having a 7-digit read-out in a size 23 housing, are in an advanced stage of development.

SPECIFICATIONS

	TYPE LD5-2	TYPE LB5-3
Mechanical Input	Shaft rotation	Shaft rotation
Code	5-digit cyclic binary coded decimal	5-digit cyclic binary
Resolution	1 in 20 for a single instrument	1 in 32 for a single instrument
Frame size	Similar to a size 11 synchro	Similar to a size 11 synchro
Typical excitation	10 volts r.m.s. at 20 kc/s	8 volts r.m.s. at 20 kc/s
Nominal output	1.5 volts r.m.s. maximum	800 millivolts r.m.s. maximum

British patent applications Nos. 11280/57 1051/59 and 1052/59

G.E.C.

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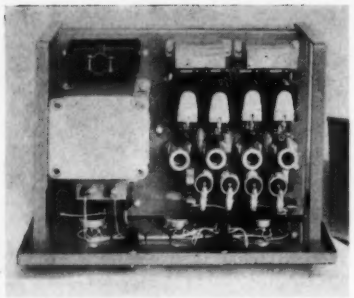


Multi-stage non-synchronous timer. Interior of three-stage model

Multi-stage Non-synchronous Timer

LANCASHIRE DYNAMO ELECTRONIC PRODUCTS LTD. announce that a number of new models of multi-stage non-synchronous timing equipment has now been added to their range of resistance welding control equipment. The new units (designated Series RCW.25) have been designed to provide a compact inexpensive assembly suitable for building into resistance welding machines and incorporate switching arrangements for air valves and electromagnetic or ignitron contactors.

Three basic units are in production for stock for two, three or four stages of time control. Typical control sequences are "Weld - Forge", "Weld - Hold - Off" and "Squeeze - Weld - Hold - Off", all with facilities for single or repetitive spot operation.

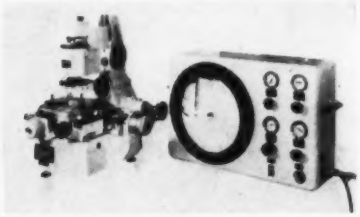
The four-stage unit is particularly suitable in view of the increasing use of pressure before weld sequences and enables the conventional pressure switch to be omitted if this is considered to be desirable. A high rate of repetitive spot welding has been achieved with this timer and welding rates of 180 spots per minute have been achieved with perfectly reliable results.

Circle **21** *for further details.*

Roundness Measuring Machine

THE instrument comprises a bearing in which a spindle carrying a gauging pick-up is power rotated at 1 r.p.m. The pick-up bears a spring-loaded controlling stylus to contact the work periphery; as the spindle is rotated the stylus moves round the periphery of the component and produces a signal in the pick-up head. This signal is amplified and fed to a circular chart recorder thereby indicating the state of roundness in documentary form.

To obtain a high degree of concentricity and low frictional torque necessary in this equipment an air bearing is used which requires a working pressure of 60 p.s.i.



Roundness measuring machine

The concentricity with this bearing is maintained to within 0·000005 in. (0·000125 mm).

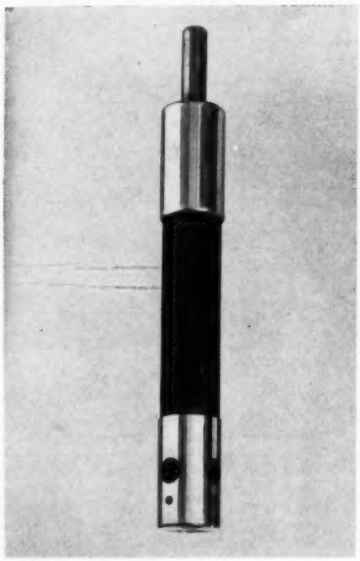
The pick-up is a pneumatic type working from a pressure of 4 p.s.i. The magnification obtained is 5,000 or 1,000, the change-over being effected by rotating a small knob at the top of bearing unit (on the recorder chart a radial space of 0·05 in. (1·25 mm) represents 0·00001 in. (0·00025 mm) at 5,000 magnification).

The bearing and measuring unit may be assembled on the O.M.T. toolmakers' microscope or can be supplied pedestal mounted. In both cases co-ordinate movements are provided to enable the workpiece to be centred beneath the axis of rotation of the measuring unit.

Measuring range of the unit for internal diameters is from $\frac{1}{8}$ in. (3 mm) to 6 in. (152 mm) and for external diameters from $\frac{1}{16}$ in. (1·5 mm) to 6 in. (152 mm).

The recording cabinet which includes an air filter, pressure regulators and pressure gauges, can be placed in any convenient position for the operator.

Circle **22** *for further details.*



"Apwar" edgefinder

Edgefinder

THE APWAR edgefinder is designed for speedy and accurate location of workpiece edge in relation to centre line of the machine spindle.

It has a $\frac{3}{8}$ in. diameter parallel shank; application, therefore, requires only a standard drill chuck, lathe chuck or collet. It is unnecessary for the body of the instrument to run absolutely true, any chuck in reasonable condition will give the desired result.

The instrument has an effective length of 6 in. and the body diameter is 1 in.

Two pins are set at right angles, providing four contact heads located on a common plane at intervals of 90 degrees round the body of the instrument. The contact pins are carefully hardened and their lengths are rigidly controlled.

Above each protruding contact head is an illumination port emitting red and green signal lights alternately, the length of the pin adjacent to the red ports having a "plus" tolerance, the other a "minus" tolerance.

In use the machine spindle is rotated slowly whilst the work edge is fed towards the APWAR edgefinder. When initial contact is made a red light signal appears.

Feed and spindle rotation is continued whilst the operator observes pin contact condition as revealed by the illumination ports. When two red light contacts and one green occur during one complete revolution the spindle centre is 0·5 in. (plus or minus 0·0001 in. under extreme conditions) from the edge of the workpiece.

Excess table feed is revealed by illumination occurring at all four contact points during one complete revolution of the spindle.

The instrument is available from stock and costs £4 17s. 6d.

Circle **23** *for further details.*

Stabilised High Voltage Supply

THE Philips stabilised high voltage supply (PW.4024) has been designed for radiation detectors with operating voltages of up to 2,500 V positive or negative. It has the following features: built-in voltmeter for reading high voltages; multiple sockets with high voltage concentric outlet, providing for connection of detectors with built-in cathode follower or amplifier; and a socket for signal outlet. The high voltage is variable in steps, thus ensuring accurate reproducibility.

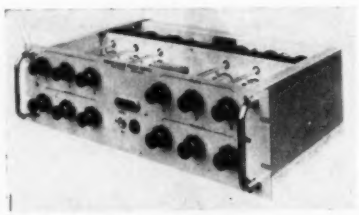
It will facilitate the operation of Geiger-Müller proportional and scintillation detectors requiring a very stable high voltage ranging from either plus 330 V to plus 2,500 V or minus 45 V to minus 2,500 V. Although one of a series of units designed to meet special requirements of radioactivity-measurement, the PW.4024 is also suitable for all other types of measurement which require a very stable positive or negative d.c. voltage.

Circle **24** *for further details.*

Strain Gauge Power Supply

THE transistorised six-channel strain gauge power supply Type AS.958 has been introduced primarily for use with the Solartron strain-gauge pressure transducers NT.4-313 and NT.4-317.

When working from transducers into a high gain amplifier (such as the Solartron AA.900 data amplifier), a normal stabilised power supply may produce a large amount of unwanted mains hum. The AS.958 is a new departure in that special transformers are employed to reduce such



Strain gauge power supply

undesirable feed-through to a figure of less than 0·1% of full-scale output.

The unit has been designed to work into bridges of a nominal 350 ohms resistance, but may also be used with resistance bridges of higher impedance. The unit is thus suitable for energising most types of strain gauges, bonded or unbonded.

Taking up only 5¼ in. of 19-in. panel space, this mains-energised power supply incorporates six individual, "fully-floating" stabilised power sub-units. Each sub-unit is capable of providing a nominal 5 volts of regulated d.c. at up to 20 milliamps. A "sensitivity" control allows variation of the output voltage by ±5%.

Also incorporated is a "balance" control capable of correcting initial bridge unbalance of up to 10% of full-scale. "Sensitivity" controls (for each channel) are brought out to the front panel and adjustments may be clamped by use of concentric control locks.

Circle **25** *for further details.*

Low-level Beta Counting Arrangement

THE Philips low-level beta counting arrangement (PW.4127) is designed to measure low specific activities of radioactive materials, and has an extremely low background count of 1·5 per minute.

Special features include a new type of guard counter, a sample counter of extremely thin window (1·5 mg/cm²), motorised sample drive and low specific activity lead shielding.

It is suitable for many applications including C14 dating, tracer work, measurement of effluents, milk, foodstuffs, etc., and many other situations in the health, physics and biological fields.

Circle **26** *for further details.*

Anti-coincidence Unit

THE Philips anti-coincidence unit (PW.4092) provides facilities for operating electronically the Philips low-level beta counting arrangement (PW.4127) or other arrangements.

The instrument consists of (a) the "count" channel and (b) the "guard" channel. In operation, the pulses from the detector (these may be either positive or negative) measuring the sample activity are supplied to the "count" channel. This comprises a pulse amplifier and three pulse shapers. The second shaper provides for a delay of 3 μ sec. The last supplies pulses with a length of 3 μ sec.

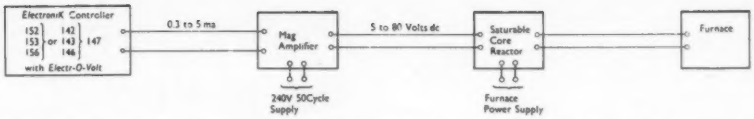
The "guard" channel receives pulses from the guard counter(s) which may also be positive or negative. This channel consists of a pulse amplifier and two pulse shapers. The length of the output pulse of the last shaper can be varied in steps by altering the value of one of the capacitors of the circuit.

The output pulses of both channels are supplied to a diode circuit.

The pulses of the "guard" channel block the circuit for a certain length of time determined by the output pulse length of the channel. During this period, the pulses of the beta counter are not passed on to the output and, consequently, do not reach the scaler.

Both "count" and "guard" channels have a separate output, so that both background count rate and sample plus background count rate may be observed.

Circle **27** *for further details.*



Electr-O-Volt control unit providing continuous temperature regulation through a magnetic amplifier and saturable core reactor

Stepless Control of Electric Power and Temperature

AN Electr-O-Volt control unit, providing continuous, contactorless regulation of electric power is available from Honeywell Controls Limited. The Electr-O-Volt, which operates with continuous balance measuring instruments, provides the most economical and accurate form of temperature control for all types of electrically-heated furnace.

By a proportional adjustment of power input when load changes occur, the Electr-O-Volt unit stabilises furnace temperature continuously, without the wear and maintenance involved in constantly operating switchgear.

Because the control action is non-cyclic, temperature changes in the heating elements occur gradually, and over a smaller range than when on/off systems are used. The furnace structure and elements are thus operating under less arduous conditions, giving longer life to certain equipment.

The Electr-O-Volt provides closer control than rapid on/off pulsing systems—on some electric furnace installations accuracies within 0·1°C are obtained.

The Electr-O-Volt provides non-interacting three-mode control—proportional, integral and derivative action. The output from the controller is a direct current varying between 0·3 and 5 m amperes, which can be fed into any load between 2,000 and 8,000 ohms. For induction or resistance heating temperature control, the Electr-O-Volt output is fed to a magnetic amplifier, the output of which is connected to the control windings of a saturable reactor. The reactor thus continuously varies power input to a furnace in order to maintain the pre-set control temperature.

The Electr-O-Volt unit finds applications in crystal growing, and all types of electrically-heated furnace. It can be used with positioners in fuel-fired installation or processing industries to give instantaneous stepless operation of control valves located at long distances from the control panel. Further applications include heat treating, annealing and diffusion furnaces, die casting, creep testing, etc.

Circle **28** *for further details.*

Potentiometer Anti-vibration Nut

THIS all-metal potentiometer anti-vibration nut is made of aluminium alloy B.S.S. 1476 H.E. 10, with internal threads ⅜ in. × 32 t.p.i. and external threads ⅜ in. × 28 t.p.i. It has a spring steel cadmium plated locking insert which gives a highly consistent performance over much wider spindle tolerances than the existing Nyloc version, which it is intended to supersede.

Priced at 55s. 0d. net per 100, the anti-vibration nuts can be supplied with identification washers made of light alloy 22 s.w.g. (0·028 in.) with anodised finish in six different colours, at 3s. 9d. net per 100. Black bakelite caps with internal threads of ⅜ in. × 28 t.p.i., suitable for use in conjunction with ¼ in. potentiometer spindle length, are available at 20s. 3d. net per 100.

Simmonds Aerocessories Ltd. also announce that in preparation are knurled lock caps for converting the anti-vibration nuts to positive spindle locking nuts, and flush mounting anti-vibration nuts which give a maximum projection over the panel of approximately 3/32 in. when used with ¼ in. spindles.

Circle **29** *for further details.*

Magnetic Amplifier

A HIGH power gain magnetic amplifier for use with Size 18 servo motor is announced by R. B. Pullin. A polarity reversible d.c. input signal is needed, which is then amplified, providing a phase reversible a.c. output signal to the control phase of the servo motor. The output voltage is in quadrature with the excitation to the magnetic amplifier. This unit has been fabricated to the general requirements of MIL-T-27 and is suitable for high temperature operation up to +125°C.

Circle **30** *for further details.*

Mercury Wetted Contact Relays

MERCURY wetted contact relays were originally developed by the Bell Telephone Laboratories to meet the special requirements of telecommunications and instrumentation. They are extensively used in the U.S.A. for switching in transistorised circuits, in computing, sorting and tabulating machines, in servo-mechanisms and as relay amplifiers.

In the mercury wetted contact relay, precious metal contacts, enclosed in a glass tube are continually wetted by mercury which is supplied to the contacts by capillary action. Consequently, the relay can be used in circuits employing up to 250 volt-amperes or in low-level circuits where contact resistance is vitally important.

The relay has a life expectation of 10^9 operations, at speeds of operation of up to 3 milliseconds, and the consistency of operation is within one per cent of the minimum operating current.

Circle **31** *for further details.*

LP.54 Manual Polarograph

THE KOVO LP.54 manual polarograph has a recorder built into the instrument, and light reflected from the galvanometer shines on the nearly transparent paper from behind. The knob which increases the voltage across the electrolyte cell also advances the recorder paper; one can thus plot the polarogram directly on to the paper. Sensitivity is similar to other d.c. polarographs. Overall size is approximately 11 × 15 × 9 in.

Circle **32** *for further details.*

Circle 101 for further information

So simple!

So surely SIMPLIFIX the foolproof coupling!

Simplifix couplings form a perfect joint on almost any kind of tubing including those with very thin walls. All that is required is tightening with a spanner – no special work is required on the tube and the anti-friction washer prevents the tube twisting when the nut is tightened. Simplifix couplings are suitable for all pipe line systems up to 2″ o.d. In a wide range of interchangeable standard fittings. Non-standard fittings of all kinds can also be made to order. Write for further information and fully illustrated catalogue.

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NEWS OF THE INDUSTRY

Telcon Aids Rocket Research

MANUFACTURE of a large quantity of 8-pair cable for instrumentation purposes has just been completed in the Greenwich factory of The Telegraph Construction & Maintenance Co. Ltd. for De Havilland Propellers Ltd. and Pye Ltd.

The cable is intended for transmission of information relating to check out signals of a complex instrumentation system, to withstand heavy vibrations over a wide frequency band, and at the same time the electrical design is such that little or no distortion of the transmitted information shall occur.

A special plastic compound (U.K. Pat. applied 10948/56) is used to cushion the pairs against vibration and shock and at the same time provide a bedding for the overall braided screen; a further polythene sheath followed by a lapped steel tape with an overall polythene sheath completes the cable.

Foxboro-Yoxall Limited—10 Year Service Club Dinner

THE 11th Annual Dinner of the Foxboro-Yoxall 10-year Service Club took place on 11th September.

The reception and dinner were held at the Wimbledon Hill Hotel and one hundred and seventeen long-service members of the staff attended. One of the purposes of this annual dinner is to welcome to the club those members of the staff who have qualified for membership in the preceding year.

The special feature of this year's dinner was that it marked the company's 25th anniversary, so that, for the first time, as well as seventeen new members for the 10-year Service Club, there were six members who had completed 25 years' service.

"Electrical Shop Window of 1959"

"ELECTRICAL Shop Window of 1959", produced for the Exhibition Organising Committee, Electrical Engineers (A.S.E.E.) Exhibition Ltd., is the first high-speed indoor colour exhibition film to be taken under normal lighting conditions.

It is a 16 mm documentary film with sound commentary, showing many of the highlights of the Eighth Electrical Engineers' Exhibition held at Earls Court, London, in March, 1959.

It was first presented in London on 14th October, 1959, at a reception for representatives of British Government Departments, of Foreign Embassies and Legations, and leading personalities of Britain's Electrical Industry.

The colour film vividly captures much of the brilliance of the vast exhibition at which 430 manufacturers showed their latest products.

General Precision Systems Ltd. Enters Air Traffic Control Field

GENERAL PRECISION SYSTEMS LIMITED, of Aylesbury, Bucks. (formerly Air Trainers Link Limited) has entered the field of air traffic control systems and equipment for the United Kingdom, Commonwealth and European markets.

Air Chief Marshal Sir John Baker, chairman of General Precision Systems Limited, said that his company had already entered into an agreement with Decca Radar Limited for co-operation in the field of air traffic control equipment and implementation of the General Precision Systems' programme in the air traffic control field would eventually involve additional collaboration with other major companies in the British and European electronics industry.

Responsibility for the air traffic control activities of General Precision Systems Limited had been placed in a new division of the company expressly organised to furnish to the British and European governments the highest level of competence in systems engineering and equipment development for air traffic control purposes. This division is headed by Mr. E. W. Pike, a recognised international authority in this field. Mr. Pike's group will have full access to the capabilities and experience of a staff of over 500 technical personnel currently employed by the General Precision companies in the United States on the air traffic control programme for the Federal Aviation Agency. Teams of technical personnel from General Precision Laboratory Incorporated and from General Precision Systems Limited have already exchanged several visits to effect joint study of air traffic control problems.

Lancashire Dynamo Electronic Products Ltd. Planned Maintenance Scheme

LANCASHIRE DYNAMO ELECTRONIC PRODUCTS LTD. announce that they have introduced a Planned Maintenance Scheme for customers in the United Kingdom. The scheme, which will be operated by the Service & Field Operations Department, involves four visits per annum and will be undertaken on a two-year contract basis with annual payments.

The annual charge will depend upon the size and value of the equipment and a uniform scale has been adopted for the whole country. This includes a fixed charge for the visit to site, plus a percentage of the original invoice price of the equipments to be maintained.

These charges will include all travelling, travelling time and time working on site, but any replacement material or components used during the visits will be charged at normal spares list prices.

It is felt that the scheme will be of particular value to the small factory or plant where maintenance facilities and the availability of skilled personnel are likely to be limited. Larger organisations should also derive considerable benefit from the scheme, in that a regular check will be made of the performance of the equipment, thus ensuring that the original standard of operation is maintained.

West Stepless Control Course

THE informal course on the function of the saturable core reactor held by West Instrument Ltd. at the firm's London office was originally planned as two one-day courses but had to be extended to three days because of the interest shown. Fifty representatives of well-known companies interested in temperature control in plastics, atomic energy development and furnace operation attended.

The saturable core reactor is the heart of the latest development in pyrometric instruments, the stepless controller.

Southern Instruments' Mobile Unit

SOUTHERN INSTRUMENTS' new mobile demonstration unit, equipped with a comprehensive range of recording instruments, started its first journey on 2nd November. Mr. J. F. Orr and Mr. P. Linscott were in charge of this unit, and with the co-operation of the Scottish agents, Messrs. Elesco Electronics Ltd., will be visiting various industrial and Government establishments in Scotland by request.

Southern Instruments' mobile unit

Londex Representation

SOUTH WALES—T. Neesham & Co. Ltd., Cumberland House, Hotwells, Bristol, 8. Telephone: Bristol 2-8197.
KENT AND SURREY—Davis & Peters, 19 College Road, Harrow. Telephone: Harrow 5578.

Oil Refinery Control Panel

TWENTY-THREE members of the Council of British Manufacturers of Petroleum Equipment, led by Mr. G. V. Sims, director, paid a visit to the offices and works of Evershed and Vignoles Limited recently and were welcomed by the Joint Managing Director, Mr. D. D. Walker, and by Mr. W. T. Marchment, manager of the Instrumentation Division of Evershed's.

The object of the visit was to inspect a large oil refinery control panel, which will be sixty feet long when complete and will be of horseshoe shape. It is designed to control two crude distillation plants, a hydrofiner, a catalytic reformer, and a redistillation unit. This involves the provision of one hundred and twenty separate control loops each embodying an Evershed Mark IV controller, with associated transmitters and positioners as control elements.

The visitors were shown some of the specially developed manufacturing techniques which have been evolved by Evershed & Vignoles engineers, and they were then taken to see the servo motor department, and coil winding room, the process controller and amplifier department, where a demonstration model simulating plant conditions was operated.

In the company's instrumentation test room the party saw a number of products of particular interest to the oil and petroleum industries. Amongst these were a gauge for measuring accurately the average temperature throughout fluid in large tanks: a "Dionic" water purity tester, which can be fitted into existing pipe systems and which will operate an indicator or recorder: and a precise gauge designed for indicating exactly the liquid level in tanks.

Kent Instrumentation for Glamorgan Open-hearth Furnace

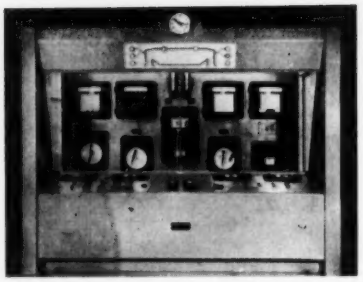
THE open-hearth furnace at the Glamorgan works of the Briton Ferry Steel Co. Limited uses instrumentation and automatic control by George Kent Ltd.

The instruments which control the 100-ton oil-fired furnace—designed by Maerz Industrie-Ofenbau A.G. of Zürich and supplied, together with the Kent equipment, to the order of Priest Furnaces Limited, Middlesbrough—are housed as a single presentation unit in a combined cabin-type panel and plate-glass-fronted control cubicle. Various instruments from the Kent range are used to indicate and record process variables—roof temperatures, checker temperatures, combustion air, oil flow, steam flow, furnace pressure, etc.—and Kent automatic control at the same time promotes overall efficiency.

Two noteworthy features are:

(1) The provision of a direction-of-firing automatic reversal system initiated by a Multelec Mark 2 temperature-difference instrument (with over-riding reversal on time interval) working in conjunction with two Land radiation pyrometers.

(2) A Commander KE electronic liquid-steel temperature indicator with a range of 1250°-1750°C.



Kent instrumentation and automatic control panel for Briton Ferry Steel Co.'s new open hearth furnace

Accessories such as selector switches, manual reversal switches, push-buttons for door opening and pneumatic auto/manual/test/service stations are externally mounted on a forward control desk, enabling instrument readings to be observed and any required adjustments to be made without entering the cubicle.

Positioned on anti-vibration mountings of the Silent-Bloc pattern, the instrument-panel/control-cubicle assembly also embodies overall panel lighting; individual instrument illumination; sealed, locking doors; and automatic pressurisation for dust exclusion.

Industrial R.F. Heating Exhibition

LATEST developments in valves and circuit techniques for radio frequency heating applications were the subject of a special three-day exhibition held last week by the Mullard Government and Industrial Valve Division, at the Electronics Centre, Mullard House. The exhibition was arranged expressly for manufacturers and users of r.f. heating equipment and for representatives of government and industrial research centres.

The company's comprehensive range of valves designed specifically for induction and dielectric heating was shown, and a number of demonstrations were given exemplifying the work undertaken by its applications research laboratories in support of equipment manufacturers and users.

The range of valves, covering frequencies up to 2,500 Mc/s and output powers up to 80 kW, included some of the latest types with "constant power" characteristics. In addition to having the robustness and reliability essential to industrial usage, these valves incorporate special design features ensuring a constant output in face of the widely varying cyclic load conditions normally encountered in dielectric and induction heating.

Amongst the working exhibits was a newly-developed "laminated" oscillator circuit, which while giving a very high order of frequency stability is simpler and less expensive than the normal cavity structure. The circuit consists of a number of interleaved metal plates, the size and distribution of which determine its operating frequency and "Q" factor under load conditions. One demonstration of the circuit showed how it could be used in dielectric heaters designed for welding plastics. In this application its frequency stability is such that the load variations imposed by welding two sheets of plastic each 18/1,000 in. thick and 5 square inches in area, cause a frequency deviation of not more than 100 kc/s from a nominal of 27·12 Mc/s.

Other demonstrations included an experimental 500 Mc/s diathermy oscillator with a radiator/reflector applicator, and a range of generators designed for investigations of the loss factors of various materials at ultra-high frequencies.

A programme of lectures was presented each day of the exhibition, the titles being as follows:

(i) The evolution of valves for r.f. heating
(ii) Reduction of spurious radiation
(iii) Power generators at v.h.f. with special valves and circuits
(iv) Heating by microwave power.

U.K. Atomic Energy Authority Orders 43 Emirad Monitors

THE United Kingdom Atomic Energy Authority has recently placed another substantial contract with E.M.I. Electronics Ltd. for its hand and clothing monitors. The order, for 43, brings the total number sold to nearly 100 since it was first announced less than a year ago.

Pacitor Aircraft Fuel Gauges

PACITOR electronic fuel gauges have been ordered for the military version of the Armstrong Whitworth Argosy Freighter (the A.W.A. 660). The gauges, which are manufactured by Firth Cleveland Instruments Ltd., a member of the Firth Cleveland Group, are also fitted to the Bristol "Britannia", Bristol 192 Helicopter, Blackburn "Beverley", Vickers Armstrong "Vanguard", Handley Page "Herald" and many other military and civil aircraft.

Pacitor gauges, developed by Firth Cleveland Instruments under contract to the Ministry of Supply, utilise a moving magnet ratiometer, giving a very compact low-weight installation. The gauge accuracy with any 100 octane petrol or aviation kerosene now in use is within ±3% over the range −20° to +70°C.

R.C.I. to Distribute Philips' Industrial Products

WITH effect from 1st November, 1959, Research and Control Instruments Ltd. became the sole distributors in the United Kingdom for the industrial products marketed by its associated company, Philips Electrical Ltd. Fully supported by the manufacturers, R.C.I. also took over the responsibility for the maintenance of existing Philips' industrial equipment.

As from the above date all correspondence relating to Philips' arc welding supplies, filtration equipment and high frequency heating generators should therefore be addressed as under.

Research and Control Instruments Ltd.,
INDUSTRIAL PRODUCTS DIVISION,
Instrument House,
207 King's Cross Road,
London, W.C.1.
Telephone No.: TERminus 2877.

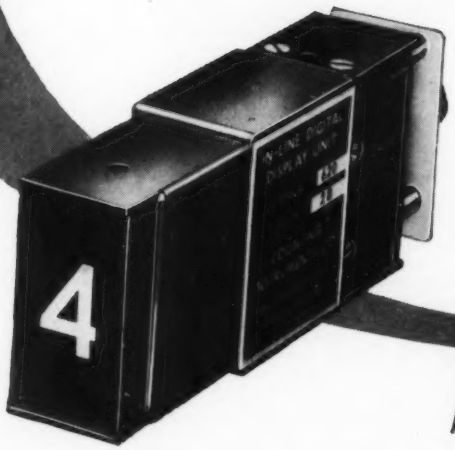
Circle 102 for further information

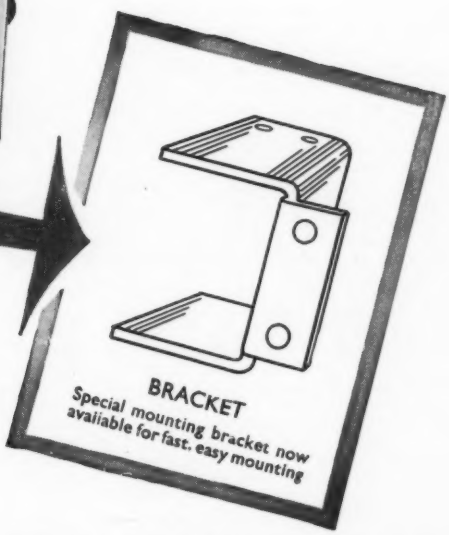
THE FINEST PROJECTION TYPE IN-LINE DISPLAYS FEATURING ONE-PLANE PRESENTATION

Here are two new type In-line Displays with all the features you have been looking for, now available with 1 in. or $\frac{5}{8}$ in. illuminated figures. All numbers, characters, and data appear on the front surface of the unit, and are uniform in size and intensity. In addition to being faster and easier to read, the information may be quickly seen from any viewing angle. Designed as a single unit, the In-line Displays may be assembled in any desired grouping, presenting a continuous surface for fast, easy reading.

ASSEMBLY

The In-line Display Units are available in groups of two or more with bracket ready for fast, easy panel mounting. Assemblies are provided with continuous viewing screen for utmost legibility and eye appeal.





BRACKET
Special mounting bracket now available for fast, easy mounting

Counting Instruments Ltd

COUNTING INSTRUMENTS LTD. 5 ELSTREE WAY, BOREHAM WOOD, HERTS.

Telephone: ELStree 1382 (4 lines)

General Controls Ltd.

THIS company has recently been formed and is the wholly owned subsidiary of General Controls Co. of California, U.S.A. It will manufacture potentiometers and associated components. The factory is at 13/15 Bowlers Croft, Honywood Road, Basildon, Essex.

John Thompson Instrument Company—Irish Agents

JOHN THOMPSON INSTRUMENT COMPANY, of Wolverhampton, have appointed the Accurate Instrument Company, of Dublin, as their Irish agents.

Large E.M.I. Computer for Ministry of Pensions

AN order for what, when completed, will be one of the largest electronic computer installations in Europe, has been placed with E.M.I. Electronics Ltd. by the Ministry of Pensions and National Insurance.

The computer, an all-transistor EMIDEC 2400, will cost over half a million pounds to manufacture and install. The computing centre will be set up at the Ministry's Newcastle establishment to deal with the huge volume of data processing connected with the new Graduated Pension Scheme.

The EMIDEC 2400 will use 17 EMIDATA fast start-stop decks and, for processing data in the "deep store", five four inch tape decks. To speed the flow of information from the computer, a new type of printer, capable of producing 3,000 lines a minute, will be used. All plug and socket connections will be gold-plated in order to ensure absolute reliability.

The EMIDEC 2400 is an advanced general-purpose high-speed computer designed for a wide range of applications in the data processing field. It embodies many new features to simplify programming and to facilitate handling of large volumes of data. Many operations such as input, output and computing proceed in parallel by means of a time sharing system which makes maximum use of the high speed of the central computer. A versatile programme interrupt feature allows a large installation with many peripheral units to be automatically programme-controlled.

I.R.D. Amalgamate with Hilger and Watts

HILGER & WATTS have acquired the whole of the issued share capital of The Infra-Red Development Co. Ltd., Welwyn Garden City.

I.R.D. Ltd. specialises in the analysis of gases by non-dispersive infra-red techniques, primarily for industrial purposes. From the start, the firm has been under the technical control and management of Mr. W. B. Bartley, who will remain managing director.

The pooling of knowledge and experience will be of great value to the two companies, and the technical, financial and manufacturing resources of the Hilger & Watts organisation will expedite further developments in gas analysis and their application in the expanding field of process control. In that field, dispersive infra-red techniques (in the use of which Hilger & Watts have had long experience) are also likely to become more important.

The Infra-Red Development Co. Ltd. will continue to operate at its works and offices in Welwyn Garden City and will continue to develop and manufacture the gas analysers on which it has built its reputation.

"Purchasing as an Aid to Productivity"

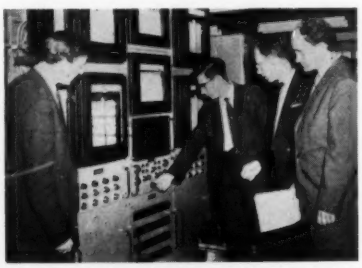
A CONFERENCE, organised by the Willesden & Hendon Productivity Committee, will be held at the headquarters of the F.B.I. at 21 Tothill Street, Westminster, S.W.1, on 27th January, 1960.

Chairman: M. Seaman, director and general manager of British Oxygen Engineering Co.

The admission fee will be 2 guineas, and requests for details and reservations, together with remittance, should be sent to: D. I. Duncan, A.E.I. Switchgear Division, 20 Neasden Lane, Willesden, N.W.10.

Burst Slug Detection Equipment

GERMAN scientists visited Plessey Nucleonics Limited at Northampton, recently, for initial acceptance tests on the burst slug detection equipment ordered for the water-cooled nuclear reactor being built at Karlsruhe in Western Germany. Examining the timing unit for the monitors are (*left to right*) Mr. M. Wilson, a development engineer and Mr. K. W. Cunningham, technical manager of Plessey Nucleonics, and Herr Kraus and Dr. Saufferer of Kernreaktor G.m.b.H.



German visitors looking at the burst slug detection equipment

Harwell Courses

THE THIRD REACTOR SCHOOL course on the Control and Instrumentation of Reactors will take place from 1st to 12th February, 1960, inclusive, and will be open to British and overseas students. It will be held at Durley Hall, Bournemouth, Hampshire.

The course is primarily intended for those who have a direct interest in the control and instrumentation of nuclear reactors, and it will be assumed that participants have some knowledge of the basic principles of these subjects.

The topics to be treated will include:—elementary reactor physics; revision of elementary reactor kinetics, control and instrumentation; automatic control of reactors and nuclear power plants; application of computers; reactor transfer functions and function analysers; neutron counting equipment; neutron flux detectors; neutron flux scanning; radiation detectors and their siting in reactors; reactor safety circuits; conventional instrumentation; use of transistors in reactor instrumentation; burst slug detection; design of control mechanisms; spatial instabilities in reactors; data reduction problems on large reactors.

In addition to the lectures there will be visits to zero energy and high flux research reactors and other relevant parts of the Harwell Establishment. There will also be a visit to the Atomic Energy Establishment, Winfrith.

The fourth course on the Control and Instrumentation of Reactors will take place from 23rd May—3rd June, 1960, inclusive, also to be held at Durley Hall, Bournemouth.

The Reactor School Standard Course No. 20 will start on 4th January and continue until 29th April, 1960.

Half the places at each course are allocated to overseas students and a fee of £250 exclusive of accommodation is charged.

A special course for Senior Technical Executives will be held from 9th to 20th May, 1960. This is the tenth course of this kind and the fee is fifty guineas exclusive of accommodation.

Application forms and details of all courses can be obtained from: The Principal, Reactor School, A.E.R.E., Harwell, Didcot, Berks.

New Addresses

Siemens Edison Swan Ltd. Leicester branch office:
247 Western Road,
Leicester.

Elliott Brothers (London) Ltd. South-West England branch office:
55 Westgate Chambers,
Newport,
Monmouthshire.
Telephone: Newport 65710.

Square D Ltd. Birmingham field office:
751 Bristol Road South,
Northfield,
Birmingham, 31.
Telephone: Priory 1163.

Levell Electronics Ltd.:
10-12 St. Albans Road,
Barnet, Herts.

Leo Computers Ltd.
Hartree House Service Station;
General Manager's Office;
Marketing Division;
Programming Division:
Hartree House,
151A-159A Queensway,
London, W.2.
Telephone: Bayswater 9451-8.

Leo I Service Station:
Cadby Hall,
London, W.14.
Telephone: Riverside 2040.
Ext. 1018.

Leo II/I Service Station:
Elms House,
Brook Green,
London, W.6.
Telephone: Riverside 2040.
Ext. 1020.

Leo Computers
Laboratories and Works:
Minerva Road,
North Acton,
London, N.W.10.
Telephone: Elgar 2894.

Price Reductions

Smiths' Components

Considerable reductions for quantity orders of certain components are announced by Smiths Aviation Division. This arrangement has been made under a new price structure covering synchros and small motors. Quantity reductions on these components range from 10% to 50% depending on the number and type of unit ordered.

For several years Smiths has manufactured a wide range of components such as synchros and servomotors for use in its range of aircraft instruments, flight systems, etc. These components have been bought in increasing numbers by other manufacturers of electronic systems, many of them outside the aircraft industry.

Philips Universal Lead Castle

	Old Price	*New Price*
PW.4122 sample slide assembly	£ s. d. 27 0 0	£ s. d. 15 0 0
PW.4123 lead disc	7 15 0	4 0 0
PW.4124 lead ring	6 0 0	3 0 0

The Philips universal lead castle can accommodate virtually all types of Geiger Müller counters, scintillation and proportional counters with a diameter up to 80 mm. It provides 35 mm of lead shielding around the detector, considerably lowering the influence of background radiation caused by cosmic and other radioactive isotopes used within the vicinity.

Philips Valve Voltmeter

Research and Control Instruments announce that the price of the Philips valve voltmeter (Type GM.6012) has been reduced from £94 0s. 0d. to £70 0s. 0d.

Expansions

Elliott Brothers (London) Ltd. has decided to form three new divisions to carry out the business at present carried out by its Aviation Division.

The three new divisions, which are located at the company's Airport works at Rochester, are: Aircraft Controls Division (manager Mr. W. H. Alexander); Aircraft Engine Instruments Division (manager Mr. F. Haskett); Aviation Service and Repair Division (manager Mr. F. Shields).

British Insulated Callender's Cables Limited announce that the wide range of products and improved facilities for customer services have enabled them to make their depot, at 58/59 Regent Street, Plymouth, into an independent branch as from 1st October, 1959. Mr. C. E. B. Baker, who has been in charge of the depot since 1945, will continue as branch manager.

Holman Brothers Ltd., Camborne, Cornwall, announce an expansion of their activities in the Midlands. Based on Birmingham and occupying new premises, the Holman Midlands branch will have a large selling and servicing organisation and will deal with all group products, i.e., the products of the parent company, Holman Brothers Ltd., as well as of the subsidiary companies, Climax Rock Drill & Engineering Ltd., Maxam Power Ltd., Goodyear Pumps Ltd. and Dustuctor Co. Ltd.

The branch is accommodated in a new building at Lightning Way, Alvechurch Road, West Heath, Birmingham, 31.

The new branch sales manager, Mr. C. E. J. Bishop, has been with the Holman Group for more than ten years and has been associated with the Midlands Area for many years, both before and since he joined the Holman Group.

Southern Instruments are opening a new branch office in the Manchester area to provide an improved service to their customers in the North of England.

Mr. G. Schofield has been appointed Northern area sales manager. Before joining Southern Instruments Mr. Schofield represented Cossor Instruments Ltd. in the North of England, and prior to this was on the Sales staff of Fielden Electronics Ltd.

The address and telephone number of the new branch area is:—

Southern Instruments Limited,
Northern Office,
536 Rochdale Road,
Shaw, Nr. Oldham, Lancs.
Telephone: Shaw 7343.

Isotope Developments' Continental Tour

THE I.D.L. mobile demonstration unit has just completed a highly successful continental tour. The vehicle, which carries a working display of laboratory and industrial nucleonic equipment visited the major universities, research laboratories, hospitals and manufacturing organisations in Belgium, Holland, Western Germany, Eastern Germany and Poland. During the tour the latest I.D.L. instruments were displayed in a special exhibition at Liege and also at the International Congress of Radiologists in Munich.

Continental Distributors Ltd.

CONTINENTAL DISTRIBUTORS LTD. have been appointed the official agents for the Nuclear Chicago Corporation of the U.S.A.

Chemical Plant Hire Scheme

METERING PUMPS LTD., of Ealing, have now introduced a plant hire scheme to enable experimental chemists and industry in general to carry out experimental work in chemical dosing and to test the effectiveness of new processes in connection with their own specific needs. This plant hire service will save much initial expenditure on precision equipment before a process is fully tested. The plant available under this scheme consists of packaged units of an electrically operated variable stroke chemical injection pump, a 20-gallon capacity rubber-lined mild steel solution tank, polythene delivery tubing and an injection fitting. All mounted on a mild steel frame. The heart of the plant is the pump and this is fitted with an ebonite pump head having a polished glass ram and synthetic rubber gland sealing rings. The pump can deliver from 0 to 3·75 gallons per hour against a pressure of up to 200 p.s.i. Any of six stroking speeds can be selected depending upon position of the two interchangeable triple groove pulleys and vee belt. These speeds are 22, 29, 38, 47, 60, and 76 s.p.m. In addition the length of stroke can be varied from zero to maximum either whilst the pump is in operation or at rest. The materials in contact with the liquid to be handled are ebonite, glass, synthetic rubber and polythene. All suitable for use in a wide range of applications. Hire charges are £4 0s. 0d. per week plus transport to and from stores. During hire, service will be carried out at no additional cost and the Metering Pumps Limited technical advice service will be freely available to clients.

National Cash Register Electronics

A REORGANISATION has taken place in the Electronics Group of The National Cash Register Company. In future, this will be known as N.C.R. Electronics.

It will be headed by Mr. D. H. Triggs as manager reponsible for sales, with Mr. R. G. Wadsworth as his assistant manager, and Mr. H. L. S. Orde as joint manager responsible for commercial and technical matters, with Mr. A. H. Beaven as his assistant manager. Mr. T. S. Chandler becomes administration manager.

Texas Semiconductor Sales Organisation

WITH the appointment of distributors in Belgium, Germany, Norway and Italy, Texas Instruments continue the expansion of their European Sales organisation. The new distributors are: Belgium, Société Industrielle Alfa S.A.; Germany, Alfred Neye GmbH; Italy, Sisram s.n.c.; Norway, Morgenstierne & Co.

Monroe Maller has been appointed European operations manager, responsible for all facets of the Texas Instruments sales organisation handling semiconductor devices throughout Western Europe, with the exception of the United Kingdom. Mr. Maller will continue to operate from Bedford, England, and will control the marketing of the complete range of Texas transistors, rectifiers and similar semiconductor devices.

EXPORT NEWS

BEAMA's Export Credit Guide

THE scarcity of capital for economic development and for the insuring of export credits has led to the creation of a large number of international and national financing organisations. Concise information on export financing bodies and export insuring schemes has been assembled in a booklet called "A Guide to the Development and Export Financing Bodies" which has been published by the British Electrical and Allied Manufacturers' Association.

Ekco Radar for Greece

EKCO airborne search radar equipment has been ordered by British European Airways for use in two de Havilland Comet 4B jet airliners on Olympic Airways' European routes.

Mr. J. Robinson (left), instruments supervisor of the Canadian Marconi Co., discussing the signal generator with Mr. Chaffey, Marconi Instruments' export manager

Marconi Instruments' Canadian Contract

MARCONI INSTRUMENTS LTD. has been awarded a further large contract for the supply of telecommunication measurement equipment to the Canadian Department of Defence Production. The order calls for 124 of the Marconi a.m. signal generator, Type TF.801D. The instruments will be used by the Royal Canadian Air Force in the maintenance of ground-to-air v.h.f. multichannel radio equipment.

The order was obtained by Marconi Instruments through their representatives in Canada, The Canadian Marconi Company. Deliveries will commence shortly.

Berec's Battery Chief to Further Britain's Export Drive

MR. GEORGE WHITE, head of Berec International Ltd., the Export Sales Division of The Ever Ready Co. (Great Britain) Ltd., flew to Africa in the latter half of October to assist in the intensifying of Berec's export drive by bigger battery sales.

This itinerary took him first to Egypt then to Kenya where in the second week of November in Nairobi he presided at a conference of all Berec sales representatives of East Africa.

From Nairobi, Mr. White went to Rhodesia and thence to South Africa where he visited Ever Ready's associate company, Eveready (S.A.) Ltd., in Port Elizabeth.

Perseus in Stockholm

THE inauguration of the first Ferranti Perseus data-processing system took place in Stockholm on Thursday, 29th October.

The ceremony was attended by a great number of Swedish officials from the business world, the Scientific Attaché of the British Embassy in Stockholm and a group representing Ferranti Ltd.

Elliott Brothers and Siemens—£120,000 Order from Australia

ELLIOTT BROTHERS (LONDON) LIMITED, a member of the Elliott-Automation Group, and Siemens Edison Swan (Australia) Pty. Limited announce that they have received orders to a value in excess of £120,000 sterling, for the supply and installation of electronic recording and control equipment for the Cockle Creek works of Sulphide Corporation Limited, in New South Wales.

The equipment to be supplied includes a completely integrated weight control and blending system regulating the feed of materials to an I.V. smelting furnace.

Completion of the order is called for by July, 1960.

Elliott Group Sells Computer to Russia

THE Russian Government has bought a U.K. electronic computer.

The machine, which is the first device of its kind to be sold to Russia, is a National-Elliott 802 transistorised general-purpose computer. It is the 115th electronic computer to be manufactured by Elliott Brothers, a member of the Elliott-Automation Group.

The Elliott 802 cost the Russians about 220,000 roubles (just under £20,000).

Although Russia has more than ten different types of digital electronic computers in full-scale production, it is believed that she is especially interested in the production of transistorised computers similar to the Elliott 802 for process control work in power plants and factories.

Two of these machines have already been sold to Belgium and one to the U.S. A further machine of the similar 803 type has been delivered also to the U.S., while seven further National-Elliott 803 computers are currently on order for supply to U.S. companies.

MANUFACTURERS' PUBLICATIONS

Precision Electrical Instruments

The range of instruments manufactured by Muirhead & Co. are described in a six-page leaflet.

Circle **33** *for further details.*

Pneumatic Relay

Leaflet (E) P99-8 gives details of a pneumatic relay for use in automatic control schemes where pneumatic control is preferred and where computing action is required.

Circle **34** *for further details.*

Lubricants for Machine Tools

Rocol have produced some notes on suggested applications of Rocol molybdenised lubricants for machine tools.

Circle **35** *for further details.*

Drying Oven

The drying oven described in leaflet S.L.6 is designed to dry chromatograms.

Circle **36** *for further details.*

Taylor Controls' Bulletins

Recent bulletins give information of the Fulscope controller, and the pneumatic Transcope recorder.

Circle **37** *for further details.*

Power Supplies and Sub-units

The sub-units may be mounted in any position and, as with the transistor power supplies, may be safely operated at ful load up to 35°C ambient temperature. Output voltage selection for the sub-units is in each case by means of 3 V coarse steps with a $\pm 1{\cdot}5$ V fine control. Data are given for chokeless power supply sub-units and for stabilised power supply sub-units.

Circle **38** *for further details.*

Transformation Printer

This projection printer is described in leaflet CS.132.

Circle **39** *for further details.*

Connectors and Terminal Clamps

The fittings are made of electrolytic copper and eliminate soldering; they are applicable to transformers, electric traction equipment, bus-bar chambers and switchgear.

Circle **40** *for further details.*

Current Overload and Underload Relays

Data sheet OR/UR gives details of operation and specification of these relays. They are applicable to heavy handling and processing equipment.

Circle **41** *for further details.*

Fraction Collector

Test tubes are held in a flexible belt of separate stainless steel links, forming a compact and easily-handled assembly. Details are given of design and construction in leaflet SL4.

Circle **42** *for further details.*

Laboratory Chemicals

An 84-page booklet gives the prices of chemicals supplied by Griffin & George Ltd.

Circle **43** *for further details.*

Portable Oxygen Analyser

This instrument analyses air or other gas for its oxygen content. The principle of operation is the magnetic susceptibility of oxygen.

Circle **44** *for further details.*

Instrument Cases

The range and prices of Kimberley instrument cases is given.

Circle **45** *for further details.*

Motor Control Gear

Details are given of direct-on-line and star-delta types in List LS.2700.

Circle **46** *for further details.*

Fused Distribution Boards

These fuseboards have been designed to provide ease of installation, and to allow facilities for future installation. Covers are dust-tight and weather-tight.

Circle **47** *for further details.*

"Stabilag" Electric Jacketed Equipment

The jacketing is made in two or three thicknesses of glass or quartz cloth. A variety of sizes and shapes are available.

Circle **48** *for further details.*

P.T.F.E. Glass Stopcock

The key needs no grease and will not seize even in the presence of caustics. The barrel and side-arms are made of Pyrex glass, thus the stopcock is easily assembled into standard apparatus.

Circle **49** *for further details.*

PERSONALITIES

Mr. J. Blake

Ferranti Appointments

Mr. W. D. H. Gregson has been appointed assistant general manager of the company's Edinburgh factory and will take up his duties towards the end of this year.

Mr. J. P. Newberry succeeds Mr. Gregson as London Area manager and Mr. P. McGregor becomes senior transformer sales engineer, London Area.

Mr. J. C. Heywood has been appointed sales manager of the Electronics Department and is succeeded in the Instrument Department by Mr. H. L. Harrison as departmental sales manager.

Mr. G. G. Ballard

Mr. G. G. Ballard has been appointed chief engineer of Elliott Nucleonics Limited. He is 29.

Mr. Ballard joined Elliotts in 1948 while still attending Enfield Technical College. He was for six months at Harwell as the company's senior engineer responsible for the installation and operation of the complete instrumentation of the Neptune Zero Energy Experimental Reactor. Mr. Ballard will now be responsible for the engineering of special instrumentation for the Bradwell Nuclear Power Station, which is being carried out by Elliott Nucleonics, and for other design and development work the company is doing in the nuclear field.

Mr. A. Calley

Mr. Andrew Calley has been appointed manager of the London District Office of Siemens Edison Swan Ltd., following the resignation of Mr. J. A. E. Trinder. Mr. Calley took over his new position on 1st November.

Since 1952 he has been manager of the London branch of the London Electric Wire Company and Smiths Ltd., a member of the A.E.I. group of companies. Mr. Calley first joined the London Electric Wire Co. in 1934 at the Liverpool branch. He entered the Royal Navy in 1939 and was awarded the M.B.E. in 1940.

Mr. H. A. Parrott

Mr. H. A. Parrott has been appointed assistant home sales manager, Cable Division of Siemens Edison Swan Ltd. He succeeds Mr. R. B. Tucker, who has resigned from the company to take up another appointment.

Mr. Parrott joined Siemens Edison Swan in May this year on a special duties assignment to the Cables Division. Previously he was with the Cable Makers' Association for 34 years, the last 11 of which were spent as secretary to the Rubber and Thermoplastic Cable Manufacturers' Association.

BICC Appointments

British Insulated Callender's Cables Limited announce that Mr. F. V. Thompson, F.C.I.S., A.A.C.C.A., has been appointed director of personnel, and has relinquished his position as secretary of the company.

Mr. J. P. Hourston, B.Com., C.A., who has been assistant secretary since 1946, has been appointed secretary.

Mr. G. V. Tew, who is a solicitor and has been on the legal staff of BICC for 7 years, is now assistant secretary.

Dr. J. C. Simmonds

J. C. Simmonds, M.Sc.(Eng.), Ph.D., M.I.E.E., M.I.Mech.E., managing director of Airmec Limited, has been appointed managing director of British Communications Corporation Ltd., and of Radio Television Trust Limited, of which Airmec is a subsidiary.

Previously with the G.P.O. Radio Branch as an assistant engineer (old style), Dr. Simmonds joined Airmec in 1946.

Mr. F. W. Leake

British Insulated Callender's Cables Limited announce with regret the death of Mr. F. W. Leake, M.I.E.E., on 14th October, after a long and distinguished career with the company.

Mr. C. W. V. Davis

Mr. C. W. V. Davis, a director of Research and Control Instruments Ltd., will head the newly-formed Industrial Products Division of that company which will in future distribute Philips arc welding supplies, filtration equipment and high frequency generators.

Mr. A. Cockle

Mr. Anthony Cockle, Grad. I.E.E., has been appointed reliability engineer of the Solartron Electronic Group.

Mr. Cockle has been engaged in guided weapon reliability engineering from 1956-59 at Vickers-Armstrong (Aircraft) Limited and E.M.I. Electronics Limited. He has been a member of the British Aircraft Construction Electronic Component Committee and was a founder member of the Ministry of Supply Guided Weapon Reliability Panel.

Mr. W. H. Statham

A South Wales Area sales office has been established by Birlec Limited in Cardiff, and Mr. W. H. Statham has been appointed the area representative. His headquarters are at Associated Electrical Industries Limited, Mervyn House, Frederick Street, Cardiff, telephone Cardiff 28511.

Mr. J. Blake

Mr. Jeffrey Blake has been appointed sales manager of Elliott's Servo Components Division. He was formerly assistant sales manager of Land Pyrometers Limited, Sheffield. He is an active member of the Society of Instrument Technology and of the Incorporated Sales Managers' Association.

Mr. H. Benton

Mr. H. Benton, Kelvin Hughes' representative for the North Wales, Cheshire and Lancashire Area has now moved to:

27 Laneside Drive,
Bramhall,
Cheshire.
Telephone: Bramhall 2841.

Smiths' Representatives

Mr. A. Eccleston, until recently Western Area representative for Smiths Industrial Instrument Division, has now taken up a post as the company's North-East Area representative. In this newly-created post he will serve Northumberland, Durham, and the North, East and West Ridings of Yorkshire.

His new office address is:

Permanent House,
The Headrow,
Leeds, 1.
Phone: Leeds 24110.

Replacing Mr. Eccleston in the Western Area is Mr. Edmond H. Smith, who joins Smiths Industrial Instrument Division from Kelvin and Hughes Industrial Ltd., where he was electro-medical representative.

Mr. Smith will be based in Bristol and his area comprises South Wales, Gloucester, Devon, Cornwall, Somerset, Dorset and Wiltshire.

Mr. W. H. Grinsted

Mr. W. H. Grinsted, O.B.E., F.C.G.I. M.I.E.E., a pioneer of telephone engineering in this country, died recently. He retired in April, 1958, from being director of engineering to Siemens Edison Swan Ltd.

Mr. R. A. Turpin

British Insulated Callender's Cables Ltd. announce that Mr. R. A. Turpin has been appointed manager of their Exeter branch, at 40 Whipton Village Road, Whipton, on the retirement of Mr. H. F. G. Bicker.

BIC Construction Co. Ltd. Board Changes

British Insulated Callender's Construction Co. Ltd. announces the retirement of Mr. C. H. Frankland, M.I.E.E., from the board and the appointment of Mr. R. Betley as an executive director of the company.

Mr. P. Iddon

Mr. John Neville having resigned from the position of representative for Multicore Solders in the London area, the vacancy has been filled by the appointment of Mr. Peter Iddon who will be directly responsible to the director of the sales division, Mr. G. A. Jarvis.

Mr. P. A. Hearne

Mr. P. A. Hearne has joined Elliott Brothers (London) Limited, a member of the Elliott-Automation Group, as divisional manager of the Guided Weapons Division.

Mr. Hearne, who is 31, was formerly sales manager of the aircraft equipment group of British Oxygen Company and before that was with B.O.A.C. and B.E.A.

Mr. A. L. Hunking

Mr. A. L. Hunking, managing director of Westool Ltd., is visiting the Warner Electric Brake and Clutch Co., and the Controls Corporation of America, whose products are manufactured under licence in this country by Westool Ltd.

Mr. K. R. Simmonds

Mr. K. R. Simmonds

Mr. K. R. Simmonds, B.Sc.(Eng.), A.M.I.E.E., has been appointed general manager of the International Rectifier Co. (Gt. Britain) Ltd., of Oxted, Surrey.

Mr. F. Briggs

Mr. F. Briggs has been appointed a director of C. S. Lindsey Ltd.

FORTHCOMING MEETINGS

Jan. 4th. **British Computer Society.** Middlesbrough Branch. Constantine Technical College, Borough Road, Middlesbrough, at 7-30 p.m. "Experience with a computer." N. C. Pollock.

Jan. 5th-7th. **Institution of Mechanical Engineers.** 1 Birdcage Walk, London, S.W.1. Symposium on recent mechanical engineering developments in automatic control.

Jan. 8th. **Society of Instrument Technology.** Fawley Section. Esso Refinery, Fawley, at 5-30 p.m. "Quality control." Dr. Millership.

Jan. 13th. **British Computer Society.** Hull Branch. Hull Chamber of Commerce, Samman House, Bowlally Lane, Hull, at 7-30 p.m. "Sorting and summarising methods for computers." C. M. Berners-Lee.

Jan. 14th. **Society of Instrument Technology.** Liverpool Section. M.A.N.W.E.B. Industrial Development Centre, Paradise Street, Liverpool, at 7-15 p.m. "The genealogy of remote control." A. L. Hancock.

Jan. 14th. **Society of Instrument Technology.** South Yorkshire Section. John Leggot Grammar School, Coal Street, Scunthorpe, at 7-30 p.m. "Automatic analytical instruments." G. H. Moss.

Jan. 20th. **Society of Instrument Technology.** Newcastle Section. Roadway House, Oxford Street, Newcastle-upon-Tyne, at 7-0 p.m. "The electronic control of water tube boilers." D. Watkins.

Jan. 21st. **Society of Instrument Technology.** East Midland Section. College of Technology and Commerce, The Newarke, Leicester, at 7-15 pm. "Instrument research at Stewart & Lloyds." M. J. Hetherington.

Jan. 25th. **Society of Instrument Technology.** Bristol Section. University of Bristol, The Royal Fort, Bristol, 8, at 7-30 p.m. "Transistors in instrumentation."

Jan. 26th. **Society of Instrument Technology.** Data Processing Section. Manson House, 26 Portland Place, London, W.1, at 7-0 p.m. Symposium on flame failure detection.

Jan. 27th. **British Computer Society.** London Branch. Northampton College of Advanced Technology, St. John Street, London, E.C.1, at 2-30 p.m. "Storage elements for very high-speed computers." Dr. G. G. Macfarlane.

Jan. 27th. **Society of Instrument Technology.** South Wales Section. Welsh College of Advanced Technology, Newport, at 6-45 p.m. "The basic principles of digital instrumentation." D. S. Evans.

Jan. 28th. **Society of Instrument Technology.** Chester Section. English Speaking Union, Stanley Palace, Watergate Street, Chester, at 7-0 p.m. "The application of method study to instrument maintenance." D. L. Smith.

Jan. 28th. **Society of Instrument Technology.** Grangemouth Section. "Ellwyn" Restaurant, Newlands Road, Grangemouth, at 7-0 p.m. "Computer control of a continuous process plant."

Feb. 1st. **Society of Instrument Technology.** South Yorkshire Section. The University, St. George's Square, Sheffield, 1, at 7-0 p.m. "Feedback—the principle of control." R. S. Medlock.

Feb. 2nd. **British Computer Society.** Middlesbrough Branch. Constantine Technical College, Borough Road, Middlesbrough, at 7-30 p.m. "Computer techniques for the recording of, and reference to, data." A. S. Douglas.

Feb. 2nd. **British Computer Society.** Newcastle Branch. University Computing Lab., 1 Kensington Terrace, Newcastle, at 7-0 p.m. "Data transmission in relation to computers and data processing systems." W. S. Ryan.

Feb. 5th. **Society of Instrument Technology.** Fawley Section. Esso Refinery, Fawley, at 5-30 p.m. "Why control processes automatically?" Prof. R. H. MacMillan.

Feb. 9th. **British Computer Society.** Manchester Branch. Manchester College of Science and Technology, Sackville Street, Manchester, at 7-0 p.m. "Production planning by computer." R. B. Baggett.

Feb. 9th. **Society of Instrument Technology.** Manchester Section. Central Library, St. Peter's Square, Manchester, 1, at 6-45 p.m. Symposium on moisture measurement.

Feb. 11th. **Society of Instrument Technology.** Control and Data Processing Sections, Manson House, 26 Portland Place, London, W.1. "Measurement, automatic control and data reduction as applied to a cyclic plant." T. A. Lucas.

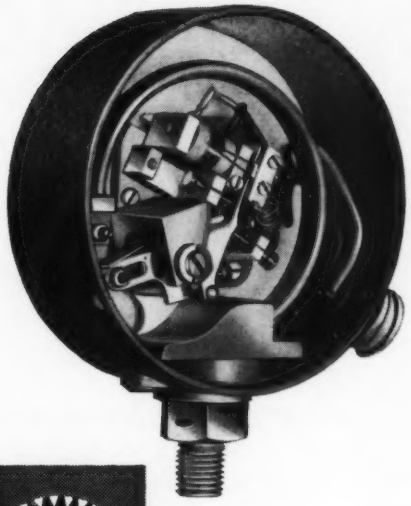
Feb. 11th. **Society of Instrument Technology.** Liverpool Section. M.A.N.W.E.B. Industrial Development Centre, Paradise Street, Liverpool, at 7-15 p.m. "Training the instrument engineer." D. P. Lant.

Feb. 12th. **Society of Instrument Technology.** Midland Section. Gosta Green College of Technology, Aston Street, Birmingham, at 7-0 p.m. "Automatic weighing." R. W. Seymour-Lee.

Feb. 18th. **Society of Instrument Technology.** Bristol Section. University of Bristol, The Royal Fort, Bristol, 8, at 7-30 p.m. "Transducers." R. Russ.

Feb. 18th. **Society of Instrument Technology.** Tees-side Section. Cleveland Scientific and Technical Institute, Corporation Road, Middlesbrough, at 7-30 p.m. "The errors of instruments—their study and importance." H. Kenney.

Circle 103 for further information



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A compact precision instrument giving high standards of accuracy (± 1% for most ranges).
Ranges available for 0-100 p.s.i. to 0-6000 p.s.i.
Overall dimensions 2½" diameter x 1 7/16" deep.
For remote indication, recording and control systems, dynamic pressure investigations and telemetering systems.

For further details write for our leaflet RTL/1

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Full details and specifications of the complete K.D.G. range are readily available from:

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Stabilised Power Supply Unit

CAT. NO. 8440

Pye Instruments

This "power pack" provides highly stabilised d.c. output voltages within the range 0 to 500V (load 250 mA max), a fixed negative supply of —250V (load 30 mA max) and a variable negative supply of 0-250V (load 1 mA max). Two separate a.c. supplies of 6·3V 5A nominal are included. These output supplies are "floating" with respect to Earth but an EARTH terminal is provided for earthing any point required. Designed for standard 19" rack mounting, but may be used on the bench.

SCIENTIFIC PYE INSTRUMENTS

Please write for our leaflets on this instrument and our latest electronic instruments, low frequency oscillators, nanoammeters and d.c. microvoltmeters, etc.

W. G. PYE & CO. LTD., GRANTA WORKS, CAMBRIDGE ENGLAND

Tel: Cambridge 54411 (5 lines) *Grams: Pye, Cambridge*

SPECIFICATION

	Positive Supply	Negative Supply
● Stabilisation (±10% power supply change)	±0·1%	±0·5%
● Output Resistance	Less than 0·75 ohm	1 ohm (on fixed range) 25,000 ohms maximum (on variable range).
● Ripple	Less than 3 mV r.m.s.	Less than 1·5 mV r.m.s.
● Output Impedance	Less than 0·75 ohm up to 50 kc/s.	Less than 1 ohm up to 1·5 kc/s.
● Input Voltage Ranges	110, 200, 220, 240 volts	40-60 c/s.
● Alternating Voltage Supplies	Two supplies are provided of 6·3V ±5% at 0-5A These supplies may be connected in series or parallel giving: (i) 6·3V nominal at 0-10A (Parallel) (ii) 12·6 V nominal at 0-5A (Series)	

Circle 104 for further information

SOCIETY OF INSTRUMENT TECHNOLOGY

South Wales Section

THE first meeting of the 1959/60 session of the South Wales Section of the Society of Instrument Technology was held in the Physics Lecture Theatre of the Cardiff College of Advanced Technology on Wednesday, 30th September, 1959, Professor R. H. Macmillan in the chair.

After welcoming members and friends, the chairman said that the Section was indebted to Dr. Bristow, Mr. Somerville Vernon's successor as head of the Physics Department of the Welsh College of Advanced Technology, for the continued use of the Physics Lecture Theatre for Section Meetings and the committee and members were appreciative of the facilities that were made available.

Mr. O. G. Pamely-Evans, said Professor Macmillan, needed no introduction to members, being a founder member of the Section and very well known in the instrument industry. In his present position as technical sales manager (Systems) of Sunvic Controls Ltd., he was actively engaged in the application of force-balance methods and would speak with authority on his subject—Force Balance Pneumatic Control.

In his opening remarks, Mr. Pamely-Evans referred to the philosophy of automatic control and explained that both a supply of energy and suitable environment were necessary to maintain any system; the basic functions of control being detection, amplification and regulation. He then described briefly the development of process control from early industrial instrumentation. These instruments were used solely in display form, their function being to convert some plant parameter into a form suitable for apprehension by human operators, the need being clarity of display. The addition of a clock-driven chart and a recording pen was a logical step forward from mere instantaneous display and although such instruments were subject to limitations, a high degree of accuracy and considerable reliability were nowadays achieved. In the next stage of development simple devices were attached to the indicator or recorder to produce power output when certain departures of the process variable from a pre-set value took place. Simple two position control systems developed into proportioning or corresponding controllers and the application of servo techniques produced the almost-universal two-term or three-term controller whose properties were now so well established. Today the accent was on control, and frequently display was not really necessary. Mr. Pamely-Evans was of the opinion that the controller should be banished from the control room to the plant itself and the aim of the manufacturer should be to produce a unit requiring little or no maintenance.

By means of a series of well chosen slides the lecturer illustrated the conventional flapper nozzle system and described the development of the force balance pneumatic circuit, the basic function being the conversion of process variables into air pressures in the international 3-15 p.s.i. range.

The expression

$$X = \frac{K_1}{K_2}\sqrt{\frac{(P_s - P_c)\,P}{(P - P_o)\,P_o}}$$ was derived

for nozzle clearance and it was pointed out that the relationship between nozzle clearance and transmitted pressure had a very definite effect on the general performance of pressure transmitting circuits.

In the simple direct nozzle system, the deviation from linearity was significant, but using compensated flow and constant differential principles the factors causing changes in clearance of the transmitter nozzle had been reduced as far as consistency with practical methods of manufacture would allow.

The force balance concept produced a radical change in design and led to a very great simplification in construction and the application of force balance techniques had produced the very efficient stack diaphragm type of pneumatic controller. The construction and operation of this compact and robust unit were explained, and it was pointed out that virtually there were no moving parts. The total displacement for extreme unbalance was only of the order of 0·002 in. which would be eliminated immediately. The simplicity of construction of the unit was admirably demonstrated by Mr. Pamely-Evans when he removed its various parts. These were very quickly re-assembled by a member of the audience and the controller put to work again. A feature of the equipment was that all pipe connections for the instrument were made to a manifold block, the controller unit being simply plugged in. On removal, all the air lines automatically sealed themselves—a feature not reproducible even electrically. The range of control available included on-off, proportional, proportional plus integral and proportional plus integral plus derivative, the derivative also being available as a separate unit with direct or inverse action.

Dealing with the application of force balance systems, the lecturer mentioned the extremely sensitive gas-filled temperature transmitter which was in effect a constant volume thermometer. He described some of the many applications of the force balance controller, including its function in conjunction with automatic logging and the use of pneumatic relays as analogue computer elements.

Finally, Mr. Pamely-Evans said that in modern practice the process controller was an integral part of the plant and no longer a delicate instrument but a high precision unit of probably greater robustness and reliability than the plant it controlled.

Following the lecture several interesting points were raised and discussed, including interaction, diaphragm memory and inverse derivative action, and the meeting closed with a vote of thanks by Professor Fishwick.

PUBLICATIONS RECEIVED

B.C.U.R.A. Gazette, (37 & 38), 1959.
B.C.U.R.A. 21st anniversary open days.

Efco Journal, 1 (1), Oct., 1959.
Some recent heat treatment developments, J. MCMULLEN.

Fairey Review, 2 (3), Sept., 1959.
Airborne profile recorder.

General Radio Experimenter, 33 (6), June, 1959.
A graphic level recorder with high sensitivity and side ranges.

General Radio Experimenter, 33 (7), July, 1959.
A close look at connection errors in capacitance measurements.
Increased accuracy for the type 1453-A and -AH decade voltage dividers.

General Radio Experimenter, 33 (8 & 9), Aug.-Sept., 1959.
The type 1305-A low frequency oscillator.
New three-terminal capacitors.

Hilger & Watts News, 10 (3), 1959.
The National Physical Laboratory, R. F. COLVILLE.

Marconi Instrumentation, 7 (3), Sept., 1959.
Atomic power instrumentation.
The Marconi ratemeter TF.1292, G. C. ZIMAN.
Digital display of time or frequency (1) Electronic counter TF.1165, D. W. BISSETT, (2) TF.1220 timing unit, P. R. DARRINGTON.
The Marconi TF.868B, E. C. CRAWFORD.

Muirhead Technique, 13 (3), July, 1959.
Compensated control for ship stabilisers, J. BELL.
The D-890 Muirhead-Wigan decade oscillator, R. F. GRIFFIN.

Panorama, 2 (3), Autumn, 1959.

Platinum Metals Review, 3 (4), Oct., 1959.
Fixed resistors for use at high temperatures.

Wild-Barfield Heat-Treatment Journal, 7 (52), Sept., 1959.
Brazing in electric furnaces.

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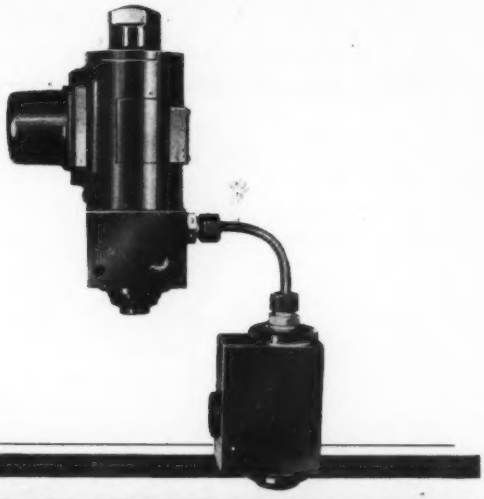

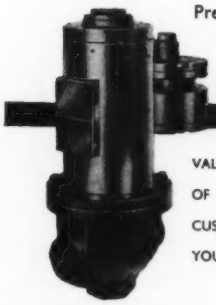

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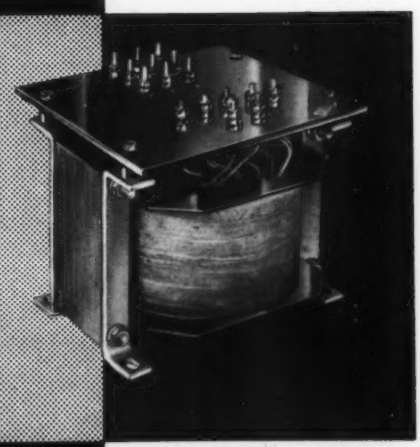

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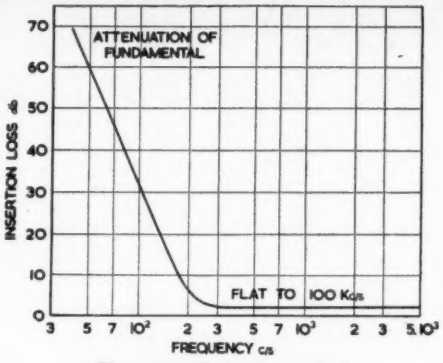

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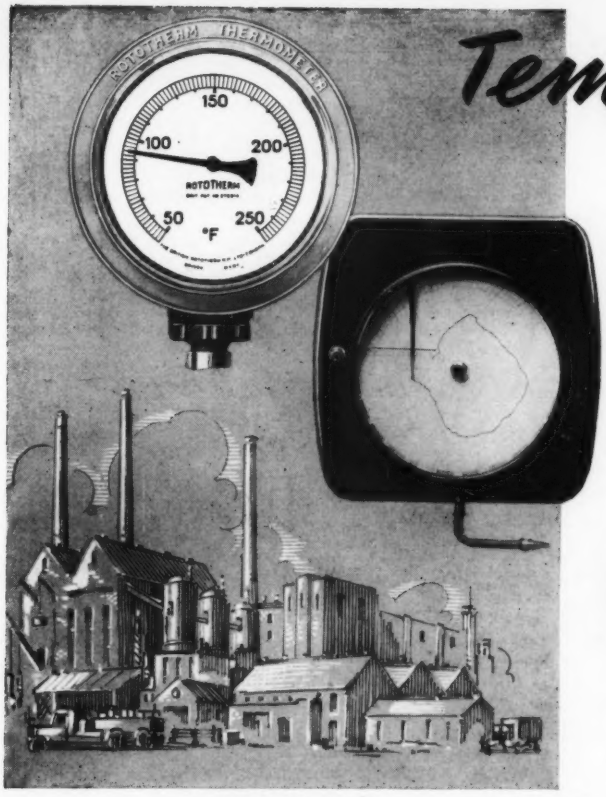

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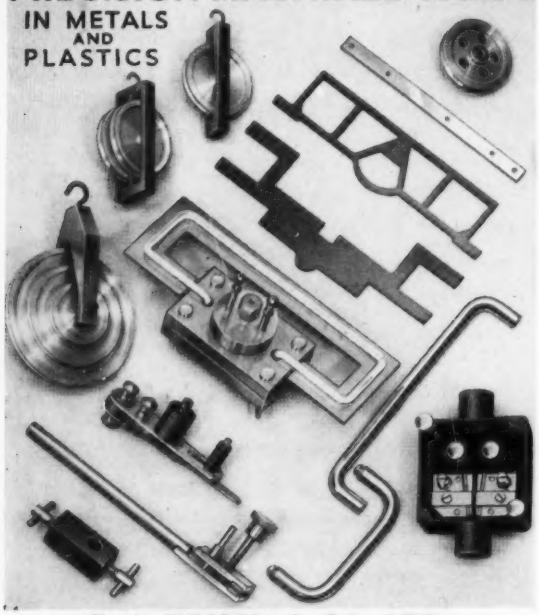

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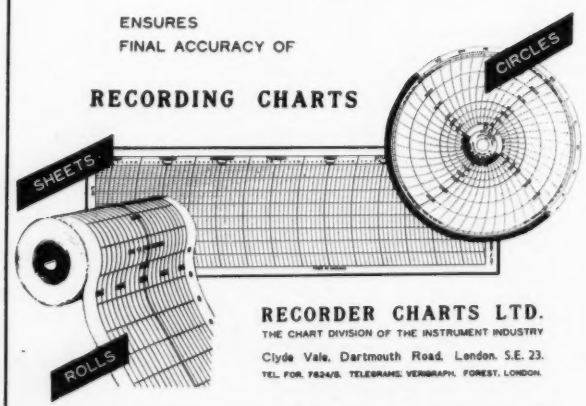

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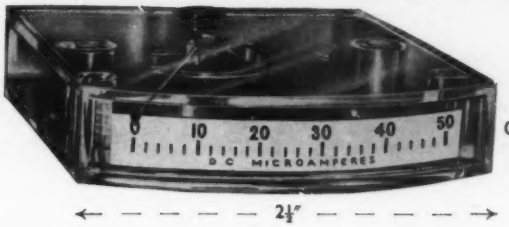

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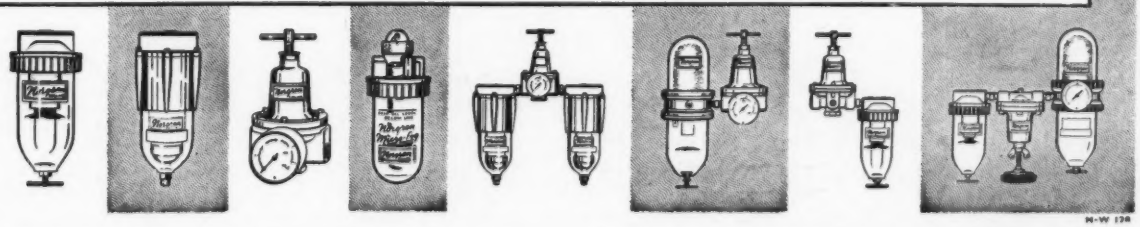

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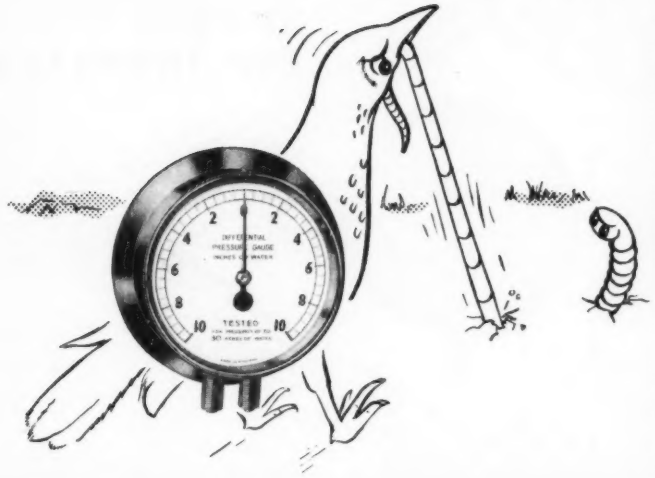

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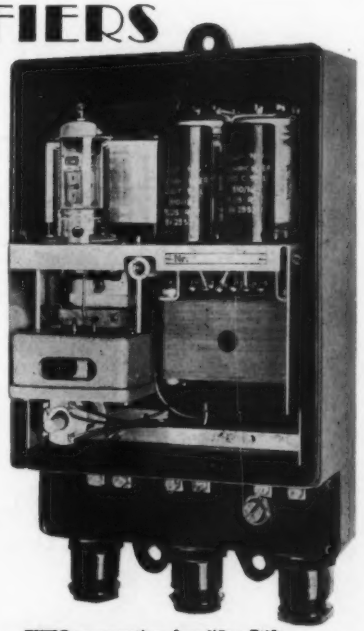

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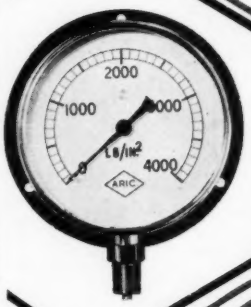

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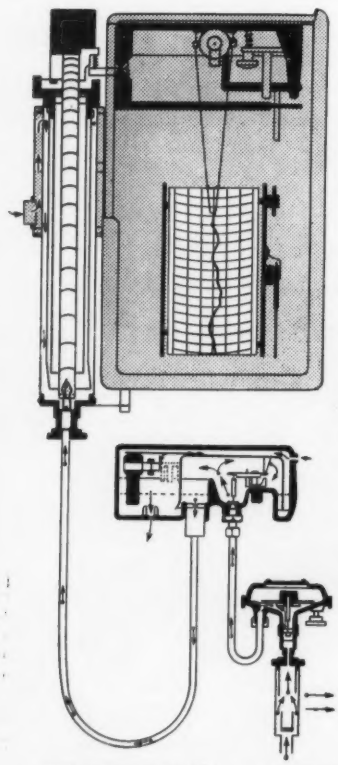

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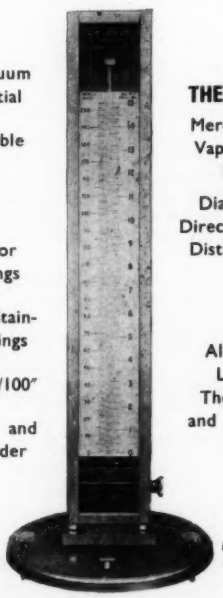

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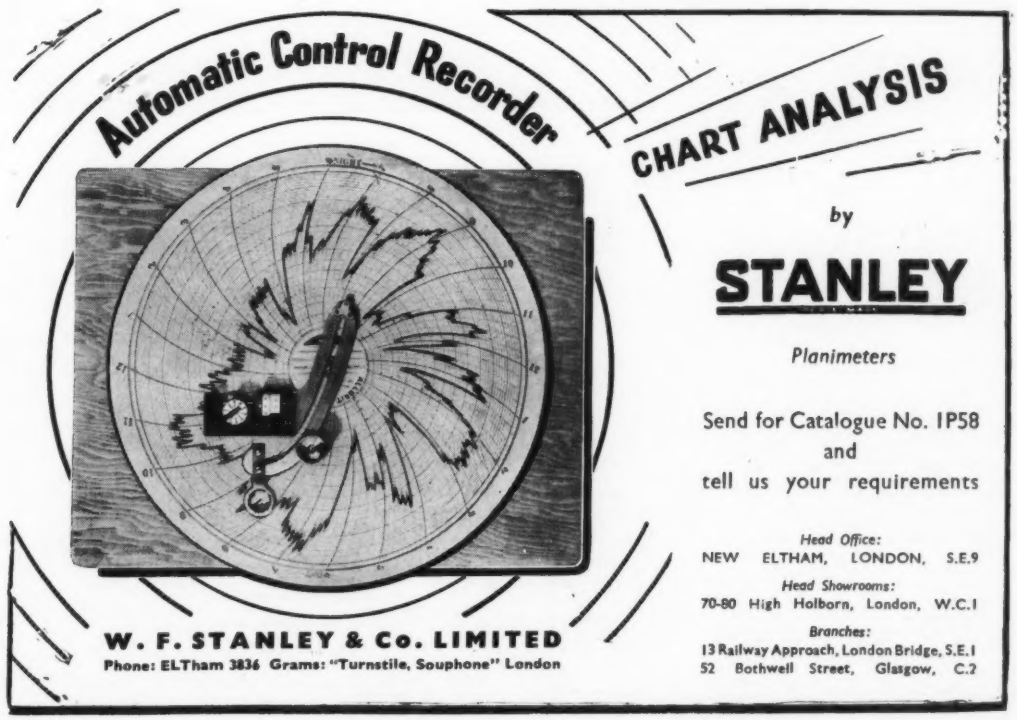

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